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Jameco Part Number 28038

FINAL

COM'L: -4/5/7/B/B-2/A, D/2 MIL: -10/12/B/B-2/A/B-4

PAL16R8 Family

20-Pin TTL Programmable Array Logic

Advanced Micro Devices

DISTINCTIVE CHARACTERISTICS

- As fast as 4.5 ns maximum propagation delay
- Popular 20-pin architectures: 16L8, 16R8, 16R6, 16R4
- Programmable replacement for high-speed TTL logic
- Register preload for testability
- Power-up reset for initialization
- Extensive third-party software and programmer support through FusionPLD partners
- 20-Pin DIP and PLCC packages save space
- 28-Pin PLCC-4 package provides ultra-clean high-speed signals

GENERAL DESCRIPTION

The PAL16R8 Family (PAL16L8, PAL16R8, PAL16R6, PAL16R4) includes the PAL16R8-5/4 Series which provides the highest speed in the 20-pin TTL PAL device family, making the series ideal for high-performance applications. The PAL16R8 Family is provided with standard 20-pin DIP and PLCC pinouts and a 28-pin PLCC pinout. The 28-pin PLCC pinout contains seven extra ground pins interleaved between the outputs to reduce noise and increase speed.

The devices provide user-programmable logic for replacing conventional SSI/MSI gates and flip-flops at a reduced chip count.

The family allows the systems engineer to implement the design on-chip, by opening fuse links to configure AND and OR gates within the device, according to the desired logic function. Complex interconnections between gates, which previously required time-consuming layout, are lifted from the PC board and placed on silicon, where they can be easily modified during prototyping or production.

The PAL device implements the familiar Boolean logic transfer function, the sum of products. The PAL device is a programmable AND array driving a fixed OR array. The AND array is programmed to create custom product terms, while the OR array sums selected terms at the outputs.

In addition, the PAL device provides the following options:

— Variable input/output pin ratio

— Programmable three-state outputs

— Registers with feedback

Product terms with all connections opened assume the logical HIGH state; product terms connected to both true and complement of any single input assume the logical LOW state. Registers consist of D-type flip-flops that are loaded on the LOW-to-HIGH transition of the clock. Unused input pins should be tied to V_{CC} or GND.

The entire PAL device family is supported by the FusionPLD partners. The PAL family is programmed on conventional PAL device programmers with appropriate personality and socket adapter modules. Once the PAL device is programmed and verified, an additional connection may be opened to prevent pattern readout. This feature secures proprietary circuits.

PRODUCT SELECTOR GUIDE

Device	Dedicated Inputs	Outputs	Product Terms/ Output	Feedback	Enable
PAL16L8	10	6 comb. 2 comb.	7 7	I/O –	prog. prog.
PAL16R8	8	8 reg.	8	reg.	pin
PAL16R6	8	6 reg. 2 comb.	8 7	reg. I/O	pin prog.
PAL16R4	8	4 reg. 4 comb.	8 7	reg. I/O	pin prog.

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Issue Date: October 1994

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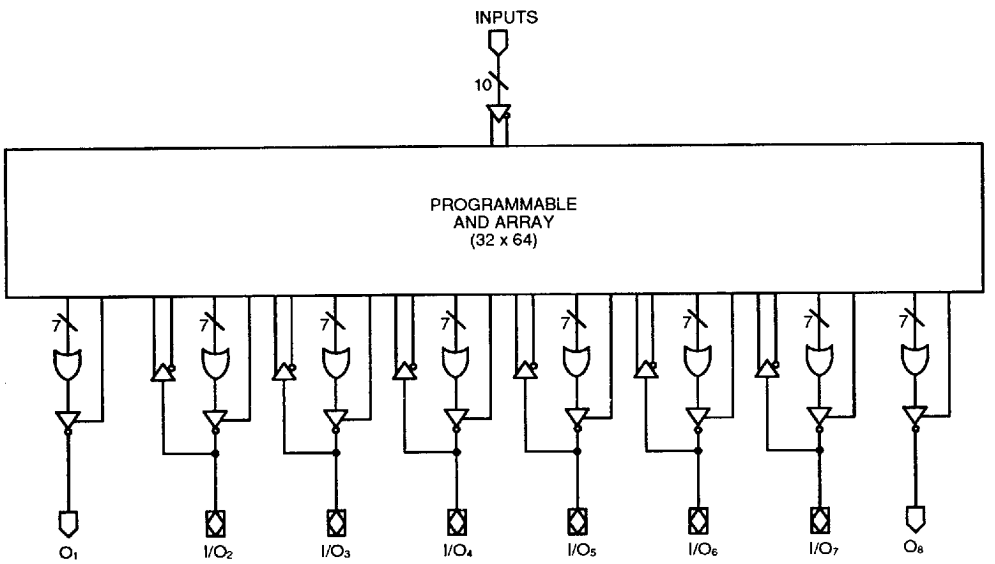
BLOCK DIAGRAMS

PAL16L8



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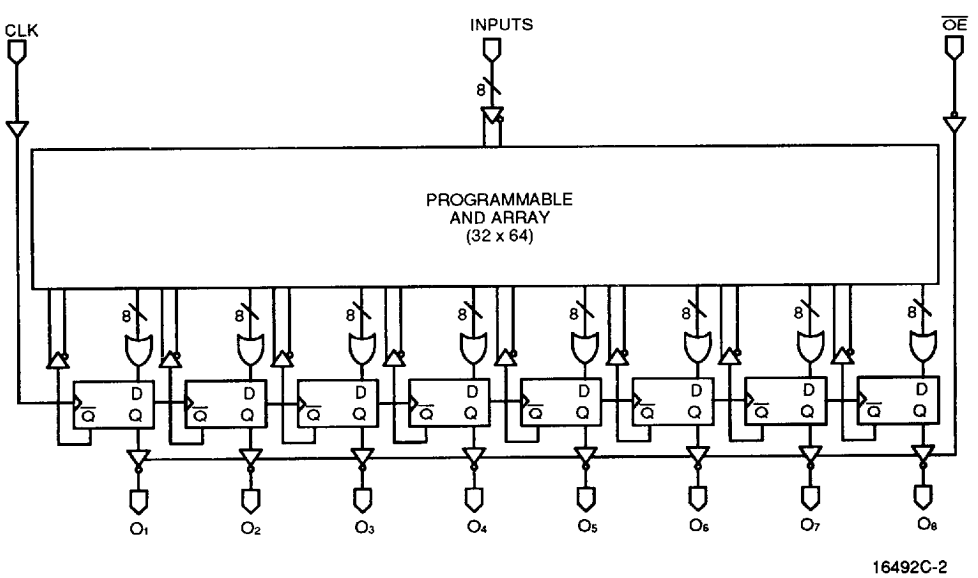
PAL16R8



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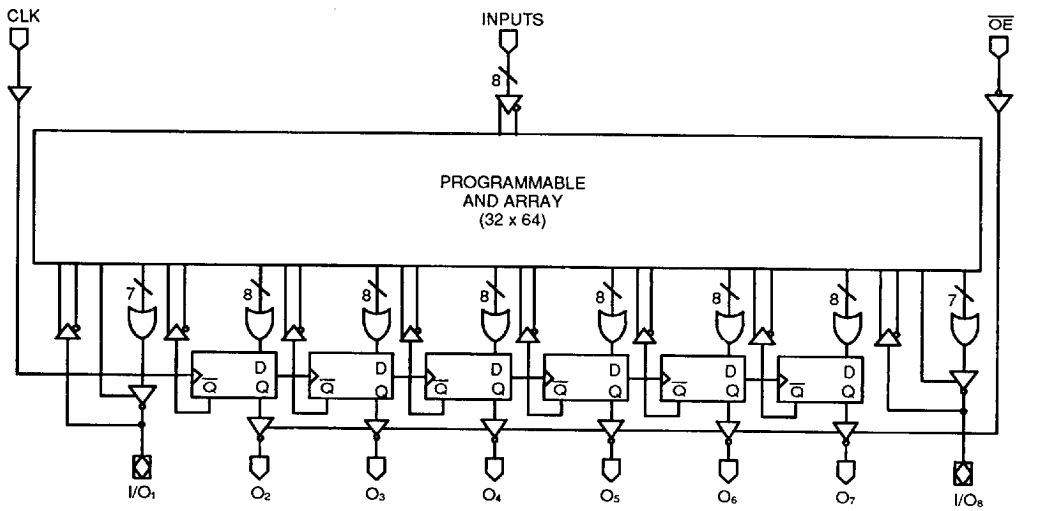
BLOCK DIAGRAMS

PAL16R6



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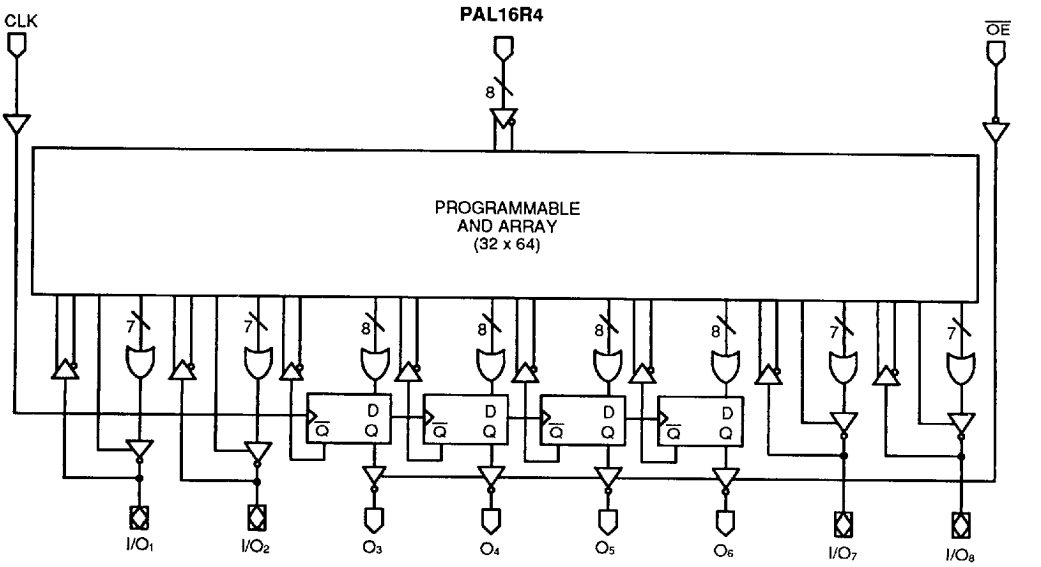
PAL16R4



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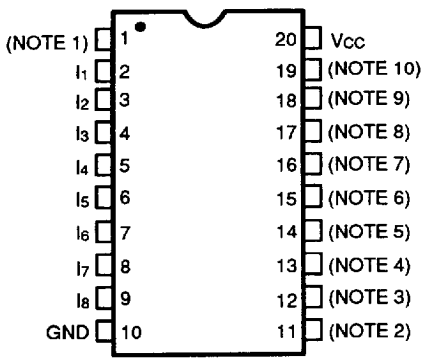
CONNECTION DIAGRAMS

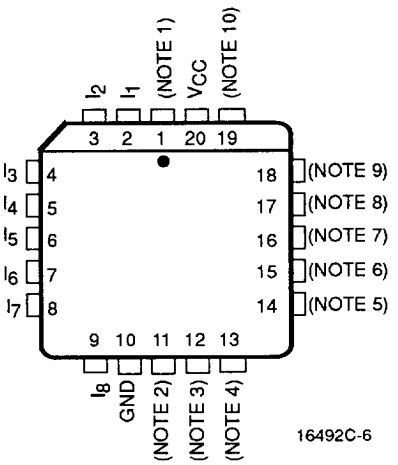
Top View

DIP



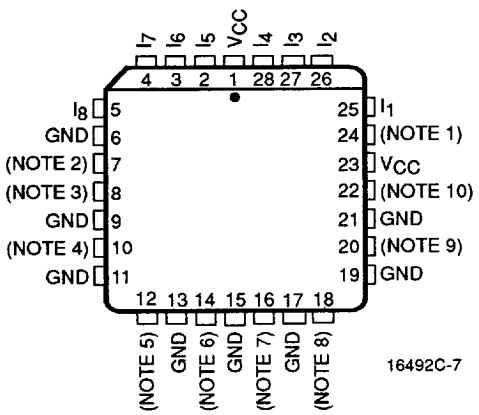
16492C-5

20-Pin PLCC



16492C-6

28-Pin PLCC



16492C-7

PIN DESIGNATIONS

CLK	=	Clock
GND	=	Ground
I	=	Input
I/O	=	Input/Output
O	=	Output
$\overline{OE}$	=	Output Enable
VCC	=	Supply Voltage

Note:

Pin 1 is marked for orientation.

Note	16L8	16R8	16R6	16R4
1	I_0	CLK	CLK	CLK
2	I_9	$\overline{OE}$	$\overline{OE}$	$\overline{OE}$
3	O_1	O_1	I/O_1	I/O_1
4	I/O_2	O_2	O_2	I/O_2
5	I/O_3	O_3	O_3	O_3
6	I/O_4	O_4	O_4	O_4
7	I/O_5	O_5	O_5	O_5
8	I/O_6	O_6	O_6	O_6
9	I/O_7	O_7	O_7	I/O_7
10	O_8	O_8	I/O_8	I/O_8

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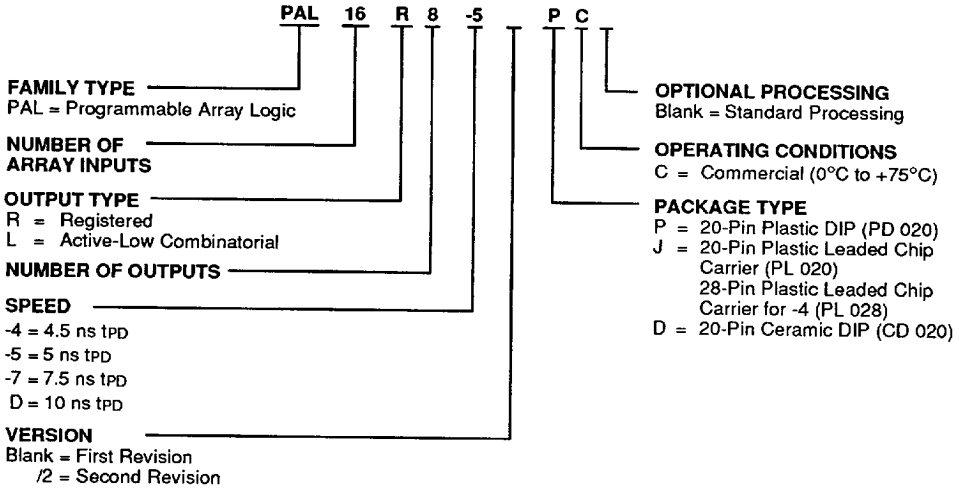
ORDERING INFORMATION
Commercial Products

AMD programmable logic products for commercial applications are available with several ordering options. The order number (Valid Combination) is formed by a combination of:


PAL 16 R 8 -5 P C
FAMILY TYPE
PAL = Programmable Array Logic
NUMBER OF ARRAY INPUTS
OUTPUT TYPE
R = Registered
L = Active-Low Combinatorial
NUMBER OF OUTPUTS
SPEED
-4 = 4.5 ns tPD
-5 = 5 ns tPD
-7 = 7.5 ns tPD
D = 10 ns tPD
VERSION
Blank = First Revision
/2 = Second Revision
OPTIONAL PROCESSING
Blank = Standard Processing
OPERATING CONDITIONS
C = Commercial (0°C to +75°C)
PACKAGE TYPE
P = 20-Pin Plastic DIP (PD 020)
J = 20-Pin Plastic Leaded Chip Carrier (PL 020)
28-Pin Plastic Leaded Chip Carrier for -4 (PL 028)
D = 20-Pin Ceramic DIP (CD 020)

Valid Combinations	
PAL16L8	-5PC, -5JC, -4JC
PAL16R8	
PAL16R6	
PAL16R4	
PAL16L8-7	PC, JC, DC
PAL16R8-7	
PAL16R6-7	
PAL16R4-7	
PAL16L8D/2	PC, JC
PAL16R8D/2	
PAL16R6D/2	
PAL16R4D/2	

Valid Combinations

Valid Combinations lists configurations planned to be supported in volume for this device. Consult the local AMD sales office to confirm availability of specific valid combinations and to check on newly released combinations.

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ORDERING INFORMATION
Commercial Products (MMI Marking Only)

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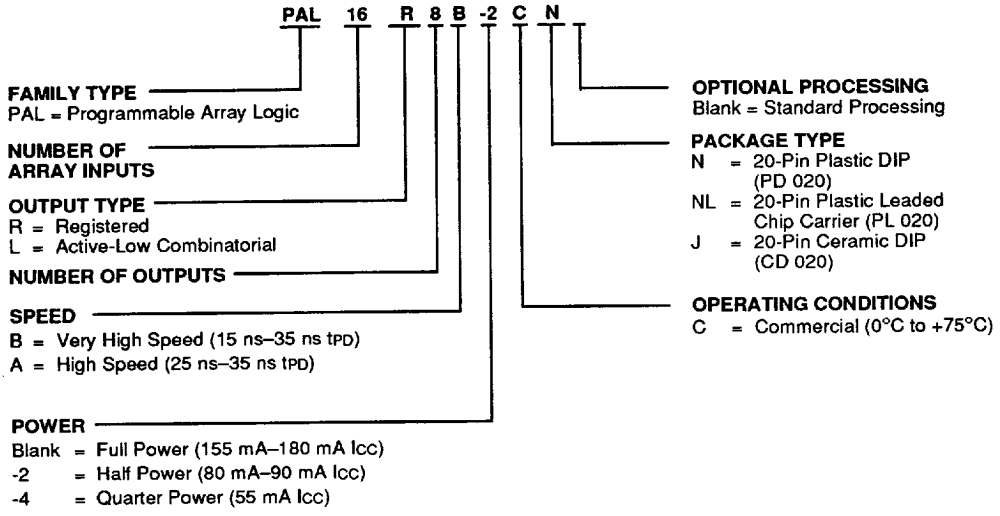
PAL 16 R 8 B -2 C N
FAMILY TYPE
PAL = Programmable Array Logic
NUMBER OF ARRAY INPUTS
OUTPUT TYPE
R = Registered
L = Active-Low Combinatorial
NUMBER OF OUTPUTS
SPEED
B = Very High Speed (15 ns–35 ns tPD)
A = High Speed (25 ns–35 ns tPD)
POWER
Blank = Full Power (155 mA–180 mA Icc)
-2 = Half Power (80 mA–90 mA Icc)
-4 = Quarter Power (55 mA Icc)
OPTIONAL PROCESSING
Blank = Standard Processing
PACKAGE TYPE
N = 20-Pin Plastic DIP (PD 020)
NL = 20-Pin Plastic Leaded Chip Carrier (PL 020)
J = 20-Pin Ceramic DIP (CD 020)
OPERATING CONDITIONS
C = Commercial (0°C to +75°C)

Valid Combinations		
PAL16L8	B, B-2, A, B-4	CN, CNL, CJ
PAL16R8		
PAL16R6		
PAL16R4		

Valid Combinations

Valid Combinations lists configurations planned to be supported in volume for this device. Consult the local AMD sales office to confirm availability of specific valid combinations and to check on newly released combinations.

Note: *Marked with MMI logo.*

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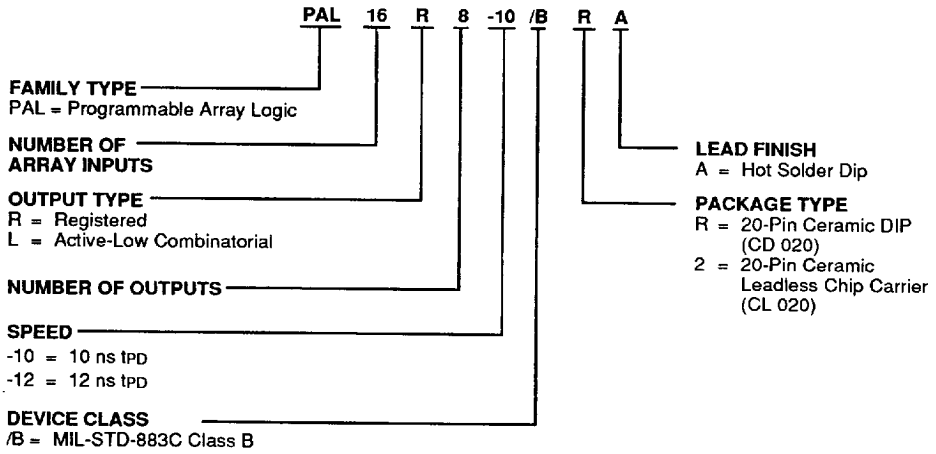
ORDERING INFORMATION

APL Products

AMD programmable logic products for Aerospace and Defense applications are available with several ordering options. APL (Approved Products List) products are fully compliant with MIL-STD-883 requirements. The order number (Valid Combination) is formed by a combination of:


PAL 16 R 8 -10 /B R A
FAMILY TYPE
PAL = Programmable Array Logic
NUMBER OF ARRAY INPUTS
OUTPUT TYPE
R = Registered
L = Active-Low Combinatorial
NUMBER OF OUTPUTS
SPEED
-10 = 10 ns tPD
-12 = 12 ns tPD
DEVICE CLASS
/B = MIL-STD-883C Class B
LEAD FINISH
A = Hot Solder Dip
PACKAGE TYPE
R = 20-Pin Ceramic DIP (CD 020)
2 = 20-Pin Ceramic Leadless Chip Carrier (CL 020)

Valid Combinations		
PAL16L8	-10, -12	/BRA, /B2A
PAL16R8		
PAL16R6		
PAL16R4		

Valid Combinations

Valid Combinations lists configurations planned to be supported in volume for this device. Consult the local AMD sales office to confirm availability of specific valid combinations and to check on newly released combinations.

Military Burn-In

Military burn-in is in accordance with the current revision of MIL-STD-883, Test Methods 1015, Conditions A through E. Test conditions are selected at AMD's option.

Group A Tests

Group A tests consist of Subgroups 1, 2, 3, 7, 8, 9, 10, 11.

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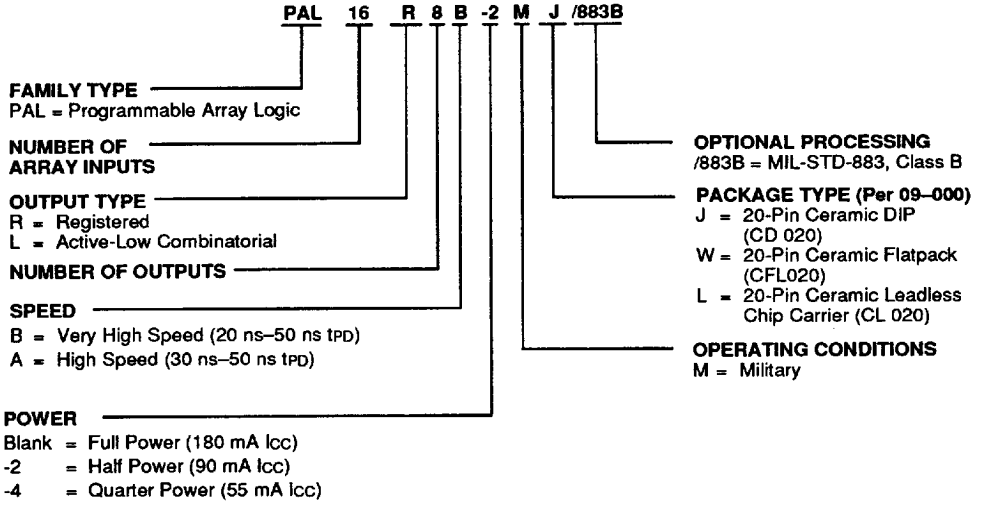
ORDERING INFORMATION
APL Products (MMI Marking Only)

AMD programmable logic products for Aerospace and Defense applications are available with several ordering options. APL (Approved Products List) products are fully compliant with MIL-STD-883 requirements. The order number (Valid Combination) is formed by a combination of:


PAL 16 R 8 B -2 M J /883B
FAMILY TYPE
PAL = Programmable Array Logic
NUMBER OF ARRAY INPUTS
OUTPUT TYPE
R = Registered
L = Active-Low Combinatorial
NUMBER OF OUTPUTS
SPEED
B = Very High Speed (20 ns–50 ns tPD)
A = High Speed (30 ns–50 ns tPD)
POWER
Blank = Full Power (180 mA Icc)
-2 = Half Power (90 mA Icc)
-4 = Quarter Power (55 mA Icc)
OPTIONAL PROCESSING
/883B = MIL-STD-883, Class B
PACKAGE TYPE (Per 09–000)
J = 20-Pin Ceramic DIP (CD 020)
W = 20-Pin Ceramic Flatpack (CFL020)
L = 20-Pin Ceramic Leadless Chip Carrier (CL 020)
OPERATING CONDITIONS
M = Military

Valid Combinations		
PAL16L8	B, B-2, A, B-4	MJ/883B, MW/883B, ML/883B
PAL16R8		
PAL16R6		
PAL16R4		

Valid Combinations

Valid Combinations lists configurations planned to be supported in volume for this device. Consult the local AMD sales office to confirm availability of specific valid combinations and to check on newly released combinations.

Note: *Marked with MMI logo.*

Military Burn-In

Military burn-in is in accordance with the current revision of MIL-STD-883, Test Methods 1015, Conditions A through E. Test conditions are selected at AMD's option.

Group A Tests

Group A tests consist of Subgroups 1, 2, 3, 7, 8, 9, 10, 11.

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FUNCTIONAL DESCRIPTION

Standard 20-Pin PAL Family

The standard bipolar 20-pin PAL family devices have common electrical characteristics and programming procedures. Four different devices are available, including both registered and combinatorial devices. All parts are produced with a fuse link at each input to the AND gate array, and connections may be selectively removed by applying appropriate voltages to the circuit. Utilizing an easily-implemented programming algorithm, these products can be rapidly programmed to any customized pattern. Extra test words are preprogrammed during manufacturing to ensure extremely high field programming yields, and provide extra test paths to achieve excellent parametric correlation.

Pinouts

The PAL16R8 Family is available in the standard 20-pin DIP and PLCC pinouts and the PAL16R8-4 Series is available in the new 28-pin PLCC pinout. The 28-pin PLCC pinout gives the designer the cleanest possible signal with only 4.5 ns delay.

The PAL16R8-4 pinout has been designed to minimize the noise that can be generated by high-speed signals. Because of its inherently shorter leads, the PLCC package is the best package for use in high-speed designs. The short leads and multiple ground signals reduce the effective lead inductance, minimizing ground bounce. Placing the ground pins between the outputs optimizes the ground bounce protection, and also isolates the outputs from each other, eliminating cross-talk. This pinout can reduce the effective propagation delay by as much as 20% from a standard DIP pinout. Design files for PAL16R8-4 Series devices are written as if the device had a standard 20-pin DIP pinout for most design software packages.

Variable Input/Output Pin Ratio

The registered devices have eight dedicated input lines, and each combinatorial output is an I/O pin. The PAL16L8 has ten dedicated input lines and six of the eight combinatorial outputs are I/O pins. Buffers for device inputs have complementary outputs to provide user-programmable input signal polarity. Unused input pins should be tied to V_{CC} or GND.

Programmable Three-State Outputs

Each output has a three-state output buffer with three-state control. On combinatorial outputs, a product term controls the buffer, allowing enable and disable to be a function of any product of device inputs or output feedback. The combinatorial output provides a bidirectional I/O pin and may be configured as a dedicated input if the output buffer is always disabled. On registered outputs, an input pin controls the enabling of the three-state outputs.

Registers with Feedback

Registered outputs are provided for data storage and synchronization. Registers are composed of D-type flip-flops that are loaded on the LOW-to-HIGH transition of the clock input.

Register Preload

The register on the AMD marked 16R8, 16R6, and 16R4 devices can be preloaded from the output pins to facilitate functional testing of complex state machine designs. This feature allows direct loading of arbitrary states, making it unnecessary to cycle through long test vector sequences to reach a desired state. In addition, transitions from illegal states can be verified by loading illegal states and observing proper recovery.

Power-Up Reset

All flip-flops power-up to a logic LOW for predictable system initialization. Outputs of the PAL16R8 Family will be HIGH due to the active-low outputs. The V_{CC} rise must be monotonic and the reset delay time is 1000 ns maximum.

Security Fuse

After programming and verification, a PAL16R8 Family design can be secured by programming the security fuse. Once programmed, this fuse defeats readback of the internal programmed pattern by a device programmer, securing proprietary designs from competitors. When the security fuse is programmed, the array will read as if every fuse is programmed.

Quality and Testability

The PAL16R8 Family offers a very high level of built-in quality. Extra programmable fuses provide a means of verifying performance of all AC and DC parameters. In addition, this verifies complete programmability and functionality of the device to provide the highest programming yields and post-programming functional yields in the industry.

Technology

The PAL16R8-5, -7 and D/2 are fabricated with AMD's oxide isolated bipolar process. The array connections are formed with highly reliable PtSi fuses. The PAL16R8B, B-2, A and B-4 series are fabricated with AMD's advanced trench-isolated bipolar process. The array connections are formed with proven TiW fuses for reliable operation. These processes reduce parasitic capacitances and minimum geometries to provide higher performance.

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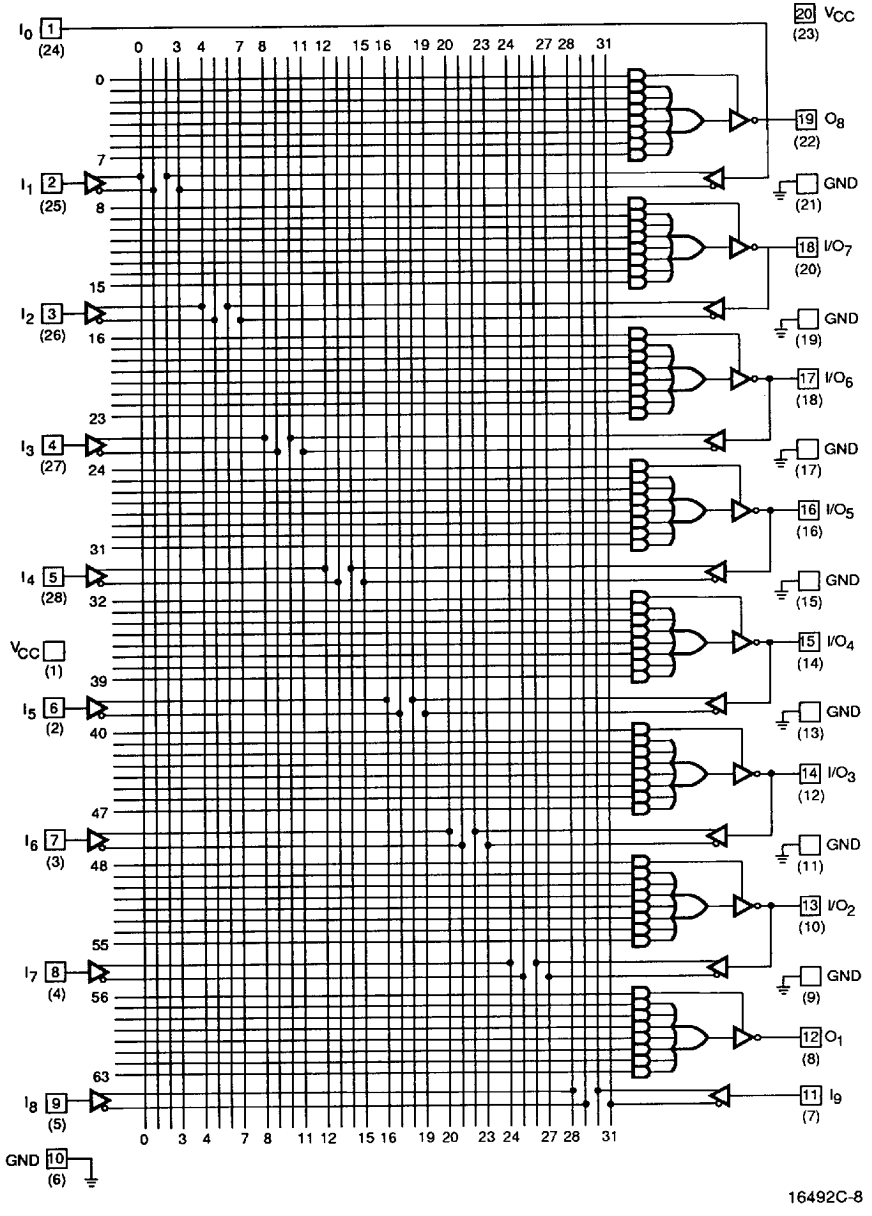
LOGIC DIAGRAM
DIP and 20-Pin PLCC (28-Pin PLCC) Pinouts

16L8 (-4)



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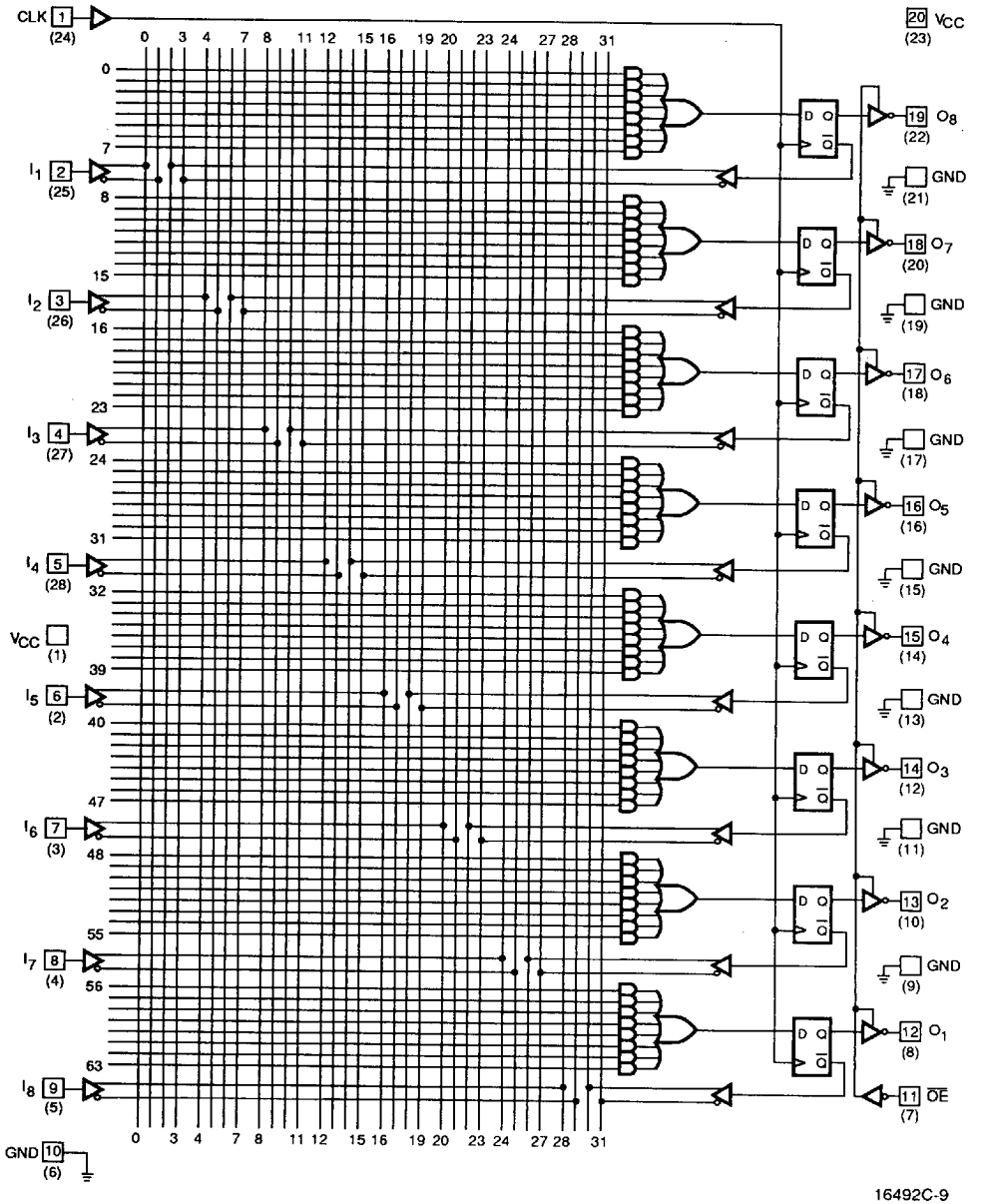
LOGIC DIAGRAM
DIP and 20-Pin PLCC (28-Pin PLCC) Pinouts

16R8 (-4)



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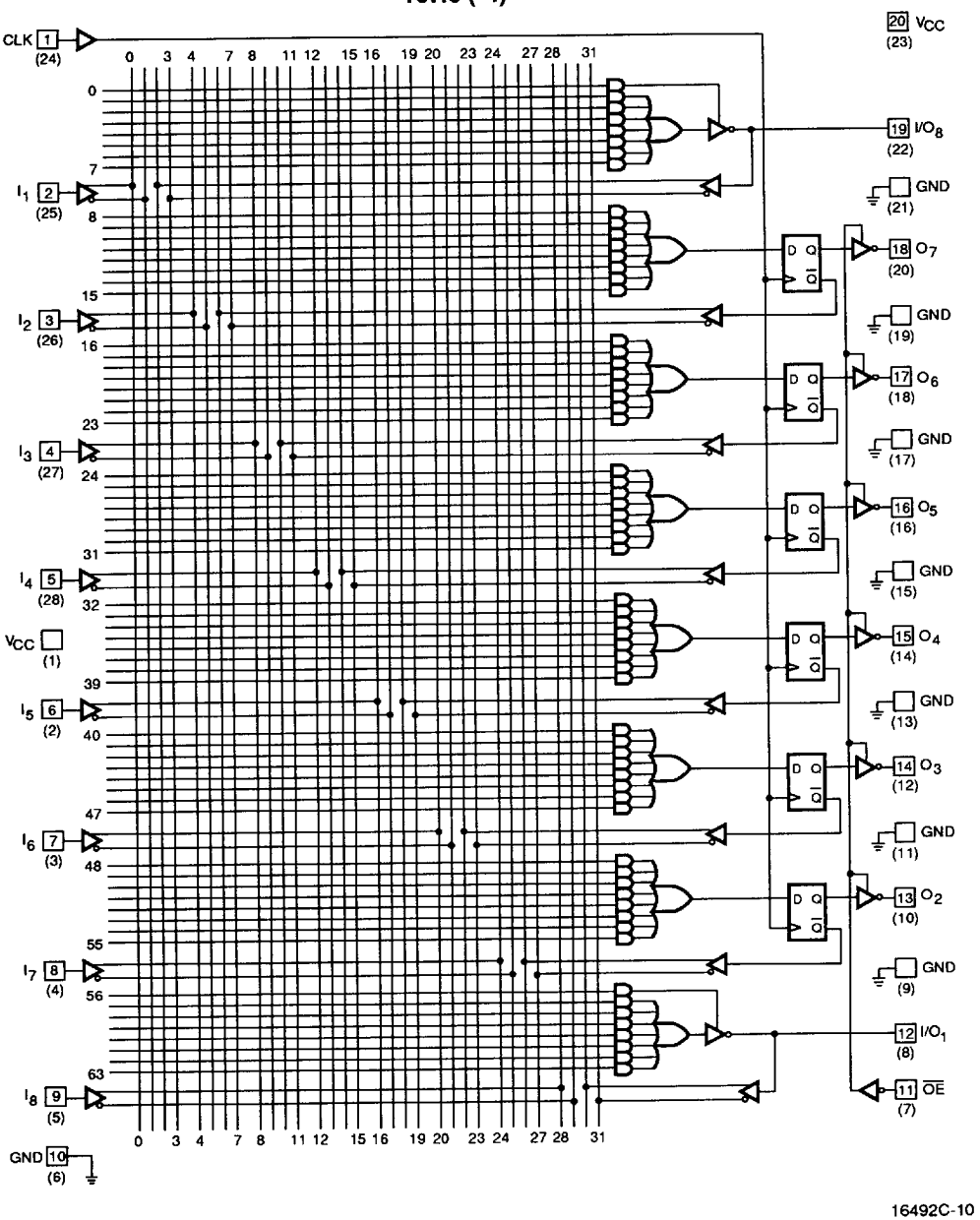
LOGIC DIAGRAM
DIP and 20-Pin PLCC (28-Pin PLCC) Pinouts

16R6 (-4)



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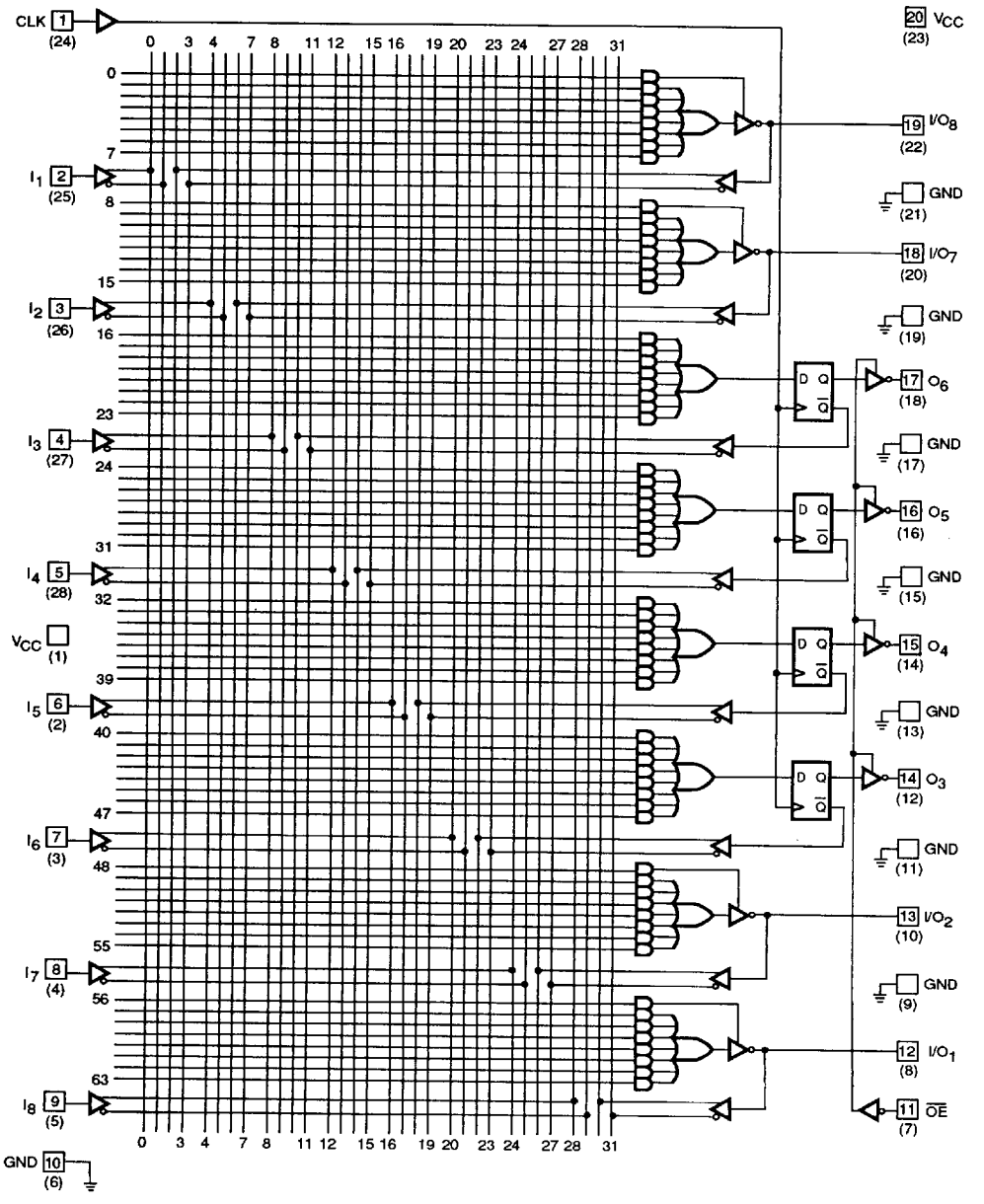
LOGIC DIAGRAM
DIP and 20-Pin PLCC (28-Pin PLCC) Pinouts

16R4 (-4)



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ABSOLUTE MAXIMUM RATINGS

Ambient Temperature with Power Applied ..... −65°C to +150°C

Storage Temperature ..... −55°C to +125°C

Supply Voltage with Respect to Ground ..... −0.5 V to + 7.0 V

DC Input Voltage ..... −1.2 V to V_{CC} + 0.5 V

DC Input Current ..... −30 mA to + 5 mA

DC Output or I/O Pin Voltage ..... −0.5 V to V_{CC} + 0.5 V

Static Discharge Voltage ..... 2001 V

Stresses above those listed under Absolute Maximum Ratings may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to Absolute Maximum Ratings for extended periods may affect device reliability. Programming conditions may differ.

OPERATING RANGES

Commercial (C) Devices

Ambient Temperature (T_A) Operating in Free Air ..... 0°C to +75°C

Supply Voltage (V_{CC}) with Respect to Ground ..... +4.75 V to +5.25 V

Operating ranges define those limits between which the functionality of the device is guaranteed.

DC CHARACTERISTICS over COMMERCIAL operating ranges unless otherwise specified

Parameter Symbol	Parameter Description	Test Conditions	Min	Max	Unit
V_{OH}	Output HIGH Voltage	I_{OH} = −3.2 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 24 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 1)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 1)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = −18 mA, V_{CC} = Min		−1.2	V
I_{IH}	Input HIGH Current	V_{IN} = 2.7 V, V_{CC} = Max (Note 2)		25	µA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max (Note 2)		−250	µA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max		1	mA
I_{OZH}	Off-State Output Leakage Current HIGH	V_{OUT} = 2.7 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 2)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 2)		−100	µA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max (Note 3)	−30	−130	mA
I_{CC}	Supply Current	V_{IN} = 0 V, Outputs Open (I_{OUT} = 0 mA) V_{CC} = Max		210	mA

Notes:

1. *These are absolute values with respect to device ground and all overshoots due to system and/or tester noise are included.*
2. *I/O pin leakage is the worst case of I_{IL} and I_{OZL} (or I_{IH} and I_{OZH}).*
3. *Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. V_{OUT} = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.*

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CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description		Test Conditions		Typ	Unit
C_{IN}	Input Capacitance	CLK, $\overline{OE}$	V_{IN} = 2.0 V	V_{CC} = 5.0 V	8	pF
		I_1–I_8		T_A = 25°C	5	
C_{OUT}	Output Capacitance		V_{OUT} = 2.0 V	f = 1 MHz	8	

Note:

1. *These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.*

SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges (Note 2)

Parameter Symbol	Parameter Description				-5 Min (Note 3)	-5 Max	-4 Min (Note 3)	-4 Max	Unit
t_{PD}	Input or Feedback to Combinatorial Output			16L8, 16R8, 16R4	1	5	1	4.5	ns
t_S	Setup Time from Input or Feedback to Clock			16R8, 16R6, 16R4	4.5		4.5		ns
t_H	Hold Time				0		0		ns
t_{CO}	Clock to Output				1	4.0	1	3.5	ns
t_{SKEWR}	Skew Between Registered Outputs (Note 4)					1		0.5	ns
t_{WL}	Clock Width	LOW			4		4		ns
t_{WH}		HIGH			4		4		ns
f_{MAX}	Maximum Frequency (Note 5)	External Feedback	$1/(t_S + t_{CO})$		117		125		MHz
		Internal Feedback (f_{CNT})			125		125		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		125		125		MHz
t_{PZX}	$\overline{OE}$ to Output Enable				1	6.5	1	6.5	ns
t_{PXZ}	$\overline{OE}$ to Output Disable				1	5	1	5	ns
t_{EA}	Input to Output Enable Using Product Term Control			16L8, 16R6, 16R4	2	6.5	2	6.5	ns
t_{ER}	Input to Output Disable Using Product Term Control				2	5	2	5	ns

Notes:

2. *See Switching Test Circuit for test conditions.*
3. *Output delay minimums for t_{PD}, t_{CO}, t_{PZX}, t_{PXZ}, t_{EA}, and t_{ER} are defined under best case conditions. Future process improvements may alter these values; therefore, minimum values are recommended for simulation purposes only.*
4. *Skew testing takes into account pattern and switching direction differences between outputs.*
5. *These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where the frequency may be affected.*

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ABSOLUTE MAXIMUM RATINGS

Storage Temperature ..... –65°C to +150°C

Ambient Temperature with Power Applied ..... –55°C to +125°C

Supply Voltage with Respect to Ground ..... –0.5 V to + 7.0 V

DC Input Voltage ..... –1.2 V to + 7.0 V

DC Input Current ..... –30 mA to + 5 mA

DC Output or I/O Pin Voltage ..... –0.5 V to V_{CC} + 0.5 V

Static Discharge Voltage ..... 2001 V

Stresses above those listed under Absolute Maximum Ratings may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to Absolute Maximum Ratings for extended periods may affect device reliability. Programming conditions may differ.

OPERATING RANGES

Commercial (C) Devices

Ambient Temperature (T_A) Operating in Free Air ..... 0°C to +75°C

Supply Voltage (V_{CC}) with Respect to Ground ..... +4.75 V to +5.25 V

Operating ranges define those limits between which the functionality of the device is guaranteed.

DC CHARACTERISTICS over COMMERCIAL operating ranges unless otherwise specified

Parameter Symbol	Parameter Description	Test Conditions	Min	Max	Unit
V_{OH}	Output HIGH Voltage	I_{OH} = –3.2 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 24 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 1)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 1)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = –18 mA, V_{CC} = Min		–1.2	V
I_{IH}	Input HIGH Current	V_{IN} = 2.7 V, V_{CC} = Max (Note 2)		25	µA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max (Note 2)		–250	µA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max		1	mA
I_{OZH}	Off-State Output Leakage Current HIGH	V_{OUT} = 2.7 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 2)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 2)		–100	µA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max (Note 3)	–30	–130	mA
I_{CC}	Supply Current	V_{IN} = 0 V, Outputs Open (I_{OUT} = 0 mA) V_{CC} = Max		180	mA

Notes:

1. *These are absolute values with respect to device ground and all overshoots due to system and/or tester noise are included.*
2. *I/O pin leakage is the worst case of I_{IL} and I_{OZL} (or I_{IH} and I_{OZH}).*
3. *Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. V_{OUT} = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.*

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CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions		Typ	Unit
C_{IN}	Input Capacitance	V_{IN} = 2.0 V	V_{CC} = 5.0 V, T_A = 25°C, f = 1 MHz	5	pF
C_{OUT}	Output Capacitance	V_{OUT} = 2.0 V		8	

Note:

1. *These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.*

SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges (Note 2)

Parameter Symbol	Parameter Description				Min (Note 3)	Max	Unit
t_{PD}	Input or Feedback to Combinatorial Output			16L8, 16R6, 16R4	3	7.5	ns
		1 Output Switching			3	7	
t_S	Setup Time from Input or Feedback to Clock			16R8, 16R6, 16R4	7		ns
t_H	Hold Time				0		ns
t_{CO}	Clock to Output				1	6.5	ns
t_{SKEW}	Skew Between Registered Outputs (Note 4)					1	ns
t_{WL}	Clock Width	LOW			5		ns
t_{WH}		HIGH			5		ns
f_{MAX}	Maximum Frequency (Note 5)	External Feedback	$1/(t_S + t_{CO})$		74		MHz
		Internal Feedback (f_{CNT})			100		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		100		MHz
t_{PZX}	$\overline{OE}$ to Output Enable				1	8	ns
t_{PXZ}	$\overline{OE}$ to Output Disable				1	8	ns
t_{EA}	Input to Output Enable Using Product Term Control			16L8, 16R6, 16R4	3	10	ns
t_{ER}	Input to Output Disable Using Product Term Control				3	10	ns

Notes:

2. *See Switching Test Circuit for test conditions.*
3. *Output delay minimums for t_{PD}, t_{CO}, t_{PZX}, t_{PXZ}, t_{EA}, and t_{ER} are defined under best case conditions. Future process improvements may alter these values; therefore, minimum values are recommended for simulation purposes only.*
4. *Skew is measured with all outputs switching in the same direction.*
5. *These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where the frequency may be affected.*

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ABSOLUTE MAXIMUM RATINGS

Storage Temperature ..... −65°C to +150°C

Ambient Temperature with Power Applied ..... −55°C to +125°C

Supply Voltage with Respect to Ground ..... −0.5 V to + 7.0 V

DC Input Voltage ..... −1.5 V to + 5.5 V

DC Output or I/O Pin Voltage ..... −0.5 V to + 5.5 V

Static Discharge Voltage ..... 2001 V

Stresses above those listed under Absolute Maximum Ratings may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to Absolute Maximum Ratings for extended periods may affect device reliability. Programming conditions may differ.

OPERATING RANGES

Commercial (C) Devices

Ambient Temperature (T_A) Operating in Free Air ..... 0°C to +75°C

Supply Voltage (V_{CC}) with Respect to Ground ..... +4.75 V to +5.25 V

Operating ranges define those limits between which the functionality of the device is guaranteed.

DC CHARACTERISTICS over COMMERCIAL operating ranges unless otherwise specified

Parameter Symbol	Parameter Description	Test Conditions	Min	Max	Unit
V_{OH}	Output HIGH Voltage	I_{OH} = −3.2 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 24 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 1)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 1)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = −18 mA, V_{CC} = Min		−1.5	V
I_{IH}	Input HIGH Current	V_{IN} = 2.4 V, V_{CC} = Max (Note 2)		25	µA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max (Note 2)		−250	µA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max		100	µA
I_{OZH}	Off-State Output Leakage Current HIGH	V_{OUT} = 2.4 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 2)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 2)		−100	µA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max (Note 3)	−30	−130	mA
I_{CC}	Supply Current	V_{IN} = 0 V, Outputs Open (I_{OUT} = 0 mA) V_{CC} = Max		180	mA

Notes:

1. *These are absolute values with respect to device ground and all overshoots due to system and/or tester noise are included.*
2. *I/O pin leakage is the worst case of I_{IL} and I_{OZL} (or I_{IH} and I_{OZH}).*
3. *Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. V_{OUT} = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.*

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CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions		Typ	Unit
C_{IN}	Input Capacitance	V_{IN} = 2.0 V	V_{CC} = 5.0 V T_A = 25°C f = 1 MHz	5	pF
C_{OUT}	Output Capacitance	V_{OUT} = 2.0 V		8	

Note:

1. *These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.*

SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges (Note 2)

Parameter Symbol	Parameter Description				Min (Note 3)	Max	Unit
t_{PD}	Input or Feedback to Combinatorial Output			16L8, 16R6, 16R4	3	10	ns
t_S	Setup Time from Input or Feedback to Clock				10		ns
t_H	Hold Time				0		ns
t_{CO}	Clock to Output				3	7	ns
t_{WL}	Clock Width	LOW			8		ns
t_{WH}		HIGH		16R8, 16R6,	8		ns
f_{MAX}	Maximum Frequency (Note 4)	External Feedback	$1/(t_S + t_{CO})$	16R4	58.8		MHz
		Internal Feedback (f_{CNT})			60		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		62.5		MHz
t_{PZX}	$\overline{OE}$ to Output Enable				2	10	ns
t_{PXZ}	$\overline{OE}$ to Output Disable				2	10	ns
t_{EA}	Input to Output Enable Using Product Term Control			16L8, 16R6,	3	10	ns
t_{ER}	Input to Output Disable Using Product Term Control			16R4	3	10	ns

Notes:

2. *See Switching Test Circuit for test conditions.*
3. *Output delay minimums for t_{PD}, t_{CO}, t_{PZX}, t_{PXZ}, t_{EA}, and t_{ER} are defined under best case conditions. Future process improvements may alter these values; therefore, minimum values are recommended for simulation purposes only.*
4. *These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where the frequency may be affected.*

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ABSOLUTE MAXIMUM RATINGS

Storage Temperature ..... −65°C to +150°C

Ambient Temperature with Power Applied ..... −55°C to +125°C

Supply Voltage with Respect to Ground ..... −0.5 V to +7.0 V

DC Input Voltage ..... −1.5 V to V_{CC} + 0.5 V

DC Output or I/O Pin Voltage ..... −0.5 V to V_{CC} + 0.5 V

Stresses above those listed under Absolute Maximum Ratings may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to Absolute Maximum Ratings for extended periods may affect device reliability. Programming conditions may differ.

OPERATING RANGES

Commercial (C) Devices

Ambient Temperature (T_A) Operating in Free Air ..... 0°C to +75°C

Supply Voltage (V_{CC}) with Respect to Ground ..... +4.75 V to +5.25 V

Operating ranges define those limits between which the functionality of the device is guaranteed.

DC CHARACTERISTICS over COMMERCIAL operating ranges unless otherwise specified

Parameter Symbol	Parameter Description	Test Conditions	Min	Max	Unit
V_{OH}	Output HIGH Voltage	I_{OH} = −3.2 mA, V_{IN} = V_{IH} or V_{IL}, V_{CC} = Min	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 24 mA, V_{IN} = V_{IH} or V_{IL}, V_{CC} = Min		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 1)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 1)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = −18 mA, V_{CC} = Min		−1.2	V
I_{IH}	Input HIGH Current	V_{IN} = 2.4 V, V_{CC} = Max (Note 2)		25	µA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max (Note 2)		−250	µA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max		100	µA
I_{OZH}	Off-State Output Leakage Current HIGH	V_{OUT} = 2.4 V, V_{CC} = Max, V_{IN} = V_{IH} or V_{IL} (Note 2)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max, V_{IN} = V_{IH} or V_{IL} (Note 2)		−100	µA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max (Note 3)	−30	−130	mA
I_{CC}	Supply Current	V_{IN} = 0 V, Outputs Open (I_{OUT} = 0 mA), V_{CC} = Max		180	mA

Notes:

1. *These are absolute values with respect to device ground and all overshoots due to system and/or tester noise are included.*
2. *I/O pin leakage is the worst case of I_{IL} and I_{OZL} (or I_{IH} and I_{OZH}).*
3. *Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. V_{OUT} = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.*

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CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions		Typ	Unit
C_{IN}	Input Capacitance	V_{IN} = 2.0 V	V_{CC} = 5.0 V, T_A = 25°C, f = 1 MHz	8	pF
C_{OUT}	Output Capacitance	V_{OUT} = 2.0 V		9	

Note:

1. These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.

SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges (Note 2)

Parameter Symbol	Parameter Description				Min	Max	Unit
t_{PD}	Input or Feedback to Combinatorial Output			16L8, 16R6, 16R4		15	ns
t_S	Setup Time from Input or Feedback to Clock			16R8, 16R6, 16R4	15		ns
t_H	Hold Time				0		ns
t_{CO}	Clock to Output or Feedback					12	ns
t_{WL}	Clock Width	LOW			10		ns
t_{WH}		HIGH			10		ns
f_{MAX}	Maximum Frequency (Note 3)	External Feedback	$1/(t_S + t_{CO})$		37		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		50		MHz
t_{PZX}	$\overline{OE}$ to Output Enable					15	ns
t_{PXZ}	$\overline{OE}$ to Output Disable					15	ns
t_{EA}	Input to Output Enable Using Product Term Control			16R8, 16R6, 16R4		15	ns
t_{ER}	Input to Output Disable Using Product Term Control					15	ns

Notes:

2. See Switching Test Circuit for test conditions.

3. These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.

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ABSOLUTE MAXIMUM RATINGS

Storage Temperature ..... −65°C to +150°C

Ambient Temperature with Power Applied ..... −55°C to +125°C

Supply Voltage with Respect to Ground ..... −0.5 V to +7.0 V

DC Input Voltage ..... −1.5 V to V_{CC} + 0.5 V

DC Output or I/O Pin Voltage ..... −0.5 V to V_{CC} + 0.5 V

Stresses above those listed under Absolute Maximum Ratings may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to Absolute Maximum Ratings for extended periods may affect device reliability. Programming conditions may differ.

OPERATING RANGES

Commercial (C) Devices

Ambient Temperature (T_A) Operating in Free Air ..... 0°C to +75°C

Supply Voltage (V_{CC}) with Respect to Ground ..... +4.75 V to +5.25 V

Operating ranges define those limits between which the functionality of the device is guaranteed.

DC CHARACTERISTICS over COMMERCIAL operating ranges unless otherwise specified

Parameter Symbol	Parameter Description	Test Conditions	Min	Max	Unit
V_{OH}	Output HIGH Voltage	I_{OH} = −3.2 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 24 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 1)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 1)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = −18 mA, V_{CC} = Min		−1.2	V
I_{IH}	Input HIGH Current	V_{IN} = 2.7 V, V_{CC} = Max (Note 2)		25	µA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max (Note 2)		−100	µA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max		100	µA
I_{OZH}	Off-State Output Leakage Current HIGH	V_{OUT} = 2.7 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 2)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 2)		−100	µA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max (Note 3)	−30	−130	mA
I_{CC}	Supply Current	V_{IN} = 0 V, Outputs Open (I_{OUT} = 0 mA) V_{CC} = Max		90	mA

Notes:

1. *These are absolute values with respect to device ground and all overshoots due to system and/or tester noise are included.*
2. *I/O pin leakage is the worst case of I_{IL} and I_{OZL} (or I_{IH} and I_{OZH}).*
3. *Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. V_{OUT} = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.*

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CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions		Typ	Unit
C_{IN}	Input Capacitance	V_{IN} = 2.0 V	V_{CC} = 5.0 V T_A = 25°C f = 1 MHz	7	pF
C_{OUT}	Output Capacitance	V_{OUT} = 2.0 V		7	

Note:

1. *These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.*

SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges (Note 2)

Parameter Symbol	Parameter Description				Min	Max	Unit
t_{PD}	Input or Feedback to Combinatorial Output			16L8, 16R6, 16R4		25	ns
t_S	Setup Time from Input or Feedback to Clock			16R8, 16R6, 16R4	25		ns
t_H	Hold Time				0		ns
t_{CO}	Clock to Output					15	ns
t_{WL}	Clock Width	LOW			15		ns
t_{WH}		HIGH			15		ns
f_{MAX}	Maximum Frequency (Note 4)	External Feedback	$1/(t_S + t_{CO})$		25		MHz
		Internal Feedback (f_{CNT})			28.5		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		33		MHz
t_{PZX}	$\overline{OE}$ to Output Enable					20	ns
t_{PXZ}	$\overline{OE}$ to Output Disable					20	ns
t_{EA}	Input to Output Enable Using Product Term Control			16R8, 16R6, 16R4		25	ns
t_{ER}	Input to Output Disable Using Product Term Control					25	ns

Notes:

2. *See Switching Test Circuit for test conditions.*
3. *Calculated from measured f_{MAX} internal.*
4. *These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.*

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ABSOLUTE MAXIMUM RATINGS

Storage Temperature ..... –65°C to +150°C

Ambient Temperature with Power Applied ..... –55°C to +125°C

Supply Voltage with Respect to Ground ..... –0.5 V to + 7.0 V

DC Input Voltage ..... –1.5 V to V_{CC} + 0.5 V

DC Output or I/O Pin Voltage ..... –0.5 V to V_{CC} + 0.5 V

Stresses above those listed under Absolute Maximum Ratings may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to Absolute Maximum Ratings for extended periods may affect device reliability. Programming conditions may differ.

OPERATING RANGES

Commercial (C) Devices

Ambient Temperature (T_A) Operating in Free Air ..... 0°C to +75°C

Supply Voltage (V_{CC}) with Respect to Ground ..... +4.75 V to +5.25 V

Operating ranges define those limits between which the functionality of the device is guaranteed.

DC CHARACTERISTICS over COMMERCIAL operating ranges unless otherwise specified

Parameter Symbol	Parameter Description		Test Conditions	Min	Max	Unit
V_{OH}	Output HIGH Voltage		I_{OH} = –3.2 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min	2.4		V
V_{OL}	Output LOW Voltage		I_{OL} = 24 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min		0.5	V
V_{IH}	Input HIGH Voltage		Guaranteed Input Logical HIGH Voltage for all Inputs (Note 1)	2.0		V
V_{IL}	Input LOW Voltage		Guaranteed Input Logical LOW Voltage for all Inputs (Note 1)		0.8	V
V_I	Input Clamp Voltage		I_{IN} = –18 mA, V_{CC} = Min		–1.2	V
I_{IH}	Input HIGH Current		V_{IN} = 2.7 V, V_{CC} = Max (Note 2)		25	µA
I_{IL}	Input LOW Current		V_{IN} = 0.4 V, V_{CC} = Max (Note 2)		–250	µA
I_I	Maximum Input Current		V_{IN} = 5.5 V, V_{CC} = Max		100	µA
I_{OZH}	Off-State Output Leakage Current HIGH		V_{OUT} = 2.7 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 2)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW		V_{OUT} = 0.4 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 2)		–100	µA
I_{SC}	Output Short-Circuit Current		V_{OUT} = 0.5 V, V_{CC} = Max (Note 3)	–30	–130	mA
I_{CC}	Supply Current	16L8	V_{IN} = 0 V, Outputs Open (I_{OUT} = 0 mA) V_{CC} = Max		155	mA
		16R8/6/4			180	

Notes:

1. *These are absolute values with respect to device ground and all overshoots due to system and/or tester noise are included.*
2. *I/O pin leakage is the worst case of I_{IL} and I_{OZL} (or I_{IH} and I_{OZH}).*
3. *Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. V_{CC} = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.*

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CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions		Typ	Unit
C_{IN}	Input Capacitance	V_{IN} = 2.0 V	V_{CC} = 5.0 V, T_A = 25°C, f = 1 MHz	7	pF
C_{OUT}	Output Capacitance	V_{OUT} = 2.0 V		7	

Note:

1. *These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.*

SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges (Note 2)

Parameter Symbol	Parameter Description				Min	Max	Unit
t_{PD}	Input or Feedback to Combinatorial Output			16L8, 16R6, 16R4		25	ns
t_S	Setup Time from Input or Feedback to Clock			16R8, 16R6, 16R4	25		ns
t_H	Hold Time				0		ns
t_{CO}	Clock to Output					15	ns
t_{WL}	Clock Width	LOW			15		ns
t_{WH}		HIGH			15		ns
f_{MAX}	Maximum Frequency (Note 4)	External Feedback	$1/(t_S + t_{CO})$		25		MHz
		Internal Feedback (f_{CNT})			28.5		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		33		MHz
t_{PZX}	$\overline{OE}$ to Output Enable					20	ns
t_{PXZ}	$\overline{OE}$ to Output Disable					20	ns
t_{EA}	Input to Output Enable Using Product Term Control			16R8, 16R6, 16R4		25	ns
t_{ER}	Input to Output Disable Using Product Term Control					25	ns

Notes:

2. *See Switching Test Circuit for test conditions.*
3. *Calculated from measured f_{MAX} internal.*
4. *These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.*

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ABSOLUTE MAXIMUM RATINGS

Storage Temperature ..... –65°C to +150°C

Ambient Temperature with Power Applied ..... –55°C to +125°C

Supply Voltage with Respect to Ground ..... –0.5 V to +7.0 V

DC Input Voltage ..... –1.5 V to +5.5 V

DC Output or I/O Pin Voltage ..... 5.5 V

Stresses above those listed under Absolute Maximum Ratings may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to Absolute Maximum Ratings for extended periods may affect device reliability. Programming conditions may differ.

OPERATING RANGES

Commercial (C) Devices

Ambient Temperature (T_A) Operating in Free Air ..... 0°C to +75°C

Supply Voltage (V_{CC}) with Respect to Ground ..... +4.75 V to +5.25 V

Operating ranges define those limits between which the functionality of the device is guaranteed.

DC CHARACTERISTICS over COMMERCIAL operating ranges unless otherwise specified

Parameter Symbol	Parameter Description	Test Conditions	Min	Max	Unit
V_{OH}	Output HIGH Voltage	I_{OH} = –1 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 8 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 1)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 1)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = –18 mA, V_{CC} = Min		–1.5	V
I_{IH}	Input HIGH Current	V_{IN} = 2.4 V, V_{CC} = Max (Note 2)		25	µA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max (Note 2)		–250	µA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max		100	µA
I_{OZH}	Off-State Output Leakage Current HIGH	V_{OUT} = 2.4 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 2)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 2)		–100	µA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max (Note 3)	–30	–250	mA
I_{CC}	Supply Current	V_{IN} = 0 V, Outputs Open (I_{OUT} = 0 mA) V_{CC} = Max		55	mA

Notes:

1. *These are absolute values with respect to device ground and all overshoots due to system and/or tester noise are included.*
2. *I/O pin leakage is the worst case of I_{IL} and I_{OZL} (or I_{IH} and I_{OZH}).*
3. *Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. V_{OUT} = 0.5 V as been chosen to avoid test problems caused by tester ground degradation.*

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SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges (Note 1)

Parameter Symbol	Parameter Description				Min	Max	Unit
t_{PD}	Input or Feedback to Combinatorial Output			16L8, 16R6, 16R4		35	ns
t_S	Setup Time from Input or Feedback to Clock			16R8, 16R6, 16R4	35		ns
t_H	Hold Time				0		ns
t_{CO}	Clock to Output or Feedback					25	ns
t_{WL}	Clock Width	LOW			25		ns
t_{WH}		HIGH			25		ns
f_{MAX}	Maximum Frequency (Note 2)	External Feedback	$1/(t_S + t_{CO})$		16		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		20		MHz
t_{PZX}	$\overline{OE}$ to Output Enable					25	ns
t_{PXZ}	$\overline{OE}$ to Output Disable					25	ns
t_{EA}	Input to Output Enable Using Product Term Control			16L8, 16R6, 16R4		35	ns
t_{ER}	Input to Output Disable Using Product Term Control					35	ns

Notes:

1. *See Switching Test Circuit for test conditions.*
2. *These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.*

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ABSOLUTE MAXIMUM RATINGS

Storage Temperature ..... –65°C to +150°C

Ambient Temperature with Power Applied ..... –55°C to +125°C

Supply Voltage with Respect to Ground ..... –0.5 V to +7.0 V

DC Input Voltage ..... –1.2 V to +5.5 V

DC Input Current ..... –30 mA to +5 mA

DC Output or I/O Pin Voltage ..... –0.5 V to V_{CC} + 0.5 V

Static Discharge Voltage ..... 2001 V

Stresses above those listed under Absolute Maximum Ratings may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to Absolute Maximum Ratings for extended periods may affect device reliability. Programming conditions may differ. Absolute Maximum Ratings are for system design reference; parameters given are not tested.

OPERATING RANGES

Military (M) Devices (Note 1)

Ambient Temperature (T_A) Operating in Free Air ..... –55°C Min

Operating Case (T_C) Temperature ..... 125°C Max

Supply Voltage (V_{CC}) with Respect to Ground ..... +4.50 V to +5.50 V

Note:

1. Military products are tested at T_C = +25°C, +125°C, and –55°C, per MIL-STD-883.

Operating ranges define those limits between which the functionality of the device is guaranteed.

DC CHARACTERISTICS over MILITARY operating ranges unless otherwise specified (Note 2)

Parameter Symbol	Parameter Description	Test Conditions	Min	Max	Unit
V_{OH}	Output HIGH Voltage	I_{OH} = –2 mA V_{IN} = V_{IH} or V_{IL}, V_{CC} = Min	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 12 mA V_{IN} = V_{IH} or V_{IL}, V_{CC} = Min		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 3)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 3)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = –18 mA, V_{CC} = Min		–1.2	V
I_{IH}	Input HIGH Current	V_{IN} = 2.7 V, V_{CC} = Max (Note 4)		25	µA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max (Note 4)		–250	µA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max		1	mA
I_{OZH}	Off-State Output Leakage Current HIGH	V_{OUT} = 2.7 V, V_{CC} = Max, V_{IN} = V_{IH} or V_{IL} (Note 4)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max, V_{IN} = V_{IH} or V_{IL} (Note 4)		–100	µA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max (Note 5)	–30	–130	mA
I_{CC}	Supply Current	V_{IN} = 0 V, Outputs Open (I_{OUT} = 0 mA), V_{CC} = Max		200	mA

Notes:

2. For APL Products, Group A, Subgroups 1, 2, and 3 are tested per MIL-STD-883, Method 5005, unless otherwise noted.

3. V_{IL} and V_{IH} are input conditions of output tests and are not themselves directly tested. V_{IL} and V_{IH} are absolute voltages with respect to device ground and include all overshoots due to system and/or tester noise. Do not attempt to test these values without suitable equipment.

4. I/O pin leakage is the worst case of I_{IL} and I_{OZL} (or I_{IH} and I_{OZH}).

5. Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. V_{OUT} = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.

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CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description		Test Conditions		Typ	Unit
C_{IN}	Input Capacitance	Corner Pins	V_{IN} = 2.0 V	V_{CC} = 5.0 V, T_A = 25°C, f = 1 MHz	10	pF
		Middle Pins			5	
C_{OUT}	Output Capacitance		V_{OUT} = 2.0 V		9	

Note:

1. *These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.*

SWITCHING CHARACTERISTICS over MILITARY operating ranges (Note 2)

Parameter Symbol	Parameter Description				-10 Min (Note 3)	-10 Max	-12 Min (Note 3)	-12 Max	Unit
t_{PD}	Input or Feedback to Combinatorial Output			16L8, 16R6, 16R4	3	10	3	12	ns
t_S	Setup Time from Input or Feedback to Clock			16R8, 16R6, 16R4	10		10		ns
t_H	Hold Time				0		0		ns
t_{CO}	Clock to Output				3	9	3	11	ns
t_{SKEW}	Skew Between Registered Outputs (Note 4)					1		1	ns
t_{WL}	Clock Width	LOW			8		8		ns
t_{WH}		HIGH			8		8		ns
f_{MAX}	Maximum Frequency (Note 5)	External Feedback	$1/(t_S + t_{CO})$		52.6		47.6		MHz
		Internal Feedback (f_{CNT})			60.6		60.6		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		62.5		62.5		MHz
t_{PZX}	$\overline{OE}$ to Output Enable (Note 5)				3	10	3	12	ns
t_{PXZ}	$\overline{OE}$ to Output Disable (Note 5)				3	10	3	12	ns
t_{EA}	Input to Output Enable Using Product Term Control (Note 5)			16L8, 16R6, 16R4	3	10	3	12	ns
t_{ER}	Input to Output Disable Using Product Term Control (Note 5)				3	10	3	12	ns

Notes:

2. *See Switching Test Circuit for test conditions. For APL products Group A, Subgroups 9, 10, and 11 are tested per MIL-STD-883, Method 5005, unless otherwise noted.*
3. *Minimum value for t_{PD}, t_{CO}, t_{PZX}, t_{PXZ}, t_{EA}, and t_{ER} parameters should be used for simulation purposes only and are not tested.*
4. *Skew is measured with all outputs switching in the same direction.*
5. *These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where these parameters may be affected.*

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ABSOLUTE MAXIMUM RATINGS

Storage Temperature ..... −65°C to +150°C

Ambient Temperature with Power Applied ..... −55°C to +125°C

Supply Voltage with Respect to Ground ..... −0.5 V to +7.0 V

DC Input Voltage ..... −1.5 V to +5.5 V

DC Output or I/O Pin Voltage ..... 5.5 V

Stresses above those listed under Absolute Maximum Ratings may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to Absolute Maximum Ratings for extended periods may affect device reliability. Programming conditions may differ. Absolute Maximum Ratings are for system design reference; parameters given are not tested.

OPERATING RANGES

Military (M) Devices (Note 1)

Ambient Temperature (T_A) Operating in Free Air ..... −55°C Min

Operating Case (T_C) Temperature ..... 125°C Max

Supply Voltage (V_{CC}) with Respect to Ground ..... +4.50 V to +5.50 V

Note:

1. *Military products are tested at T_C = +25°C, +125°C, and −55°C, per MIL-STD-883.*

Operating ranges define those limits between which the functionality of the device is guaranteed.

DC CHARACTERISTICS over MILITARY operating ranges unless otherwise specified (Note 2)

Parameter Symbol	Parameter Description	Test Conditions	Min	Max	Unit
V_{OH}	Output HIGH Voltage	I_{OH} = −2 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 12 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 3)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 3)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = −18 mA, V_{CC} = Min		−1.5	V
I_{IH}	Input HIGH Current	V_{IN} = 2.4 V, V_{CC} = Max (Note 4)		25	µA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max (Note 4)		−250	µA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max		1	mA
I_{OZH}	Off-State Output Leakage Current HIGH	V_{OUT} = 2.4 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 4)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 4)		−100	µA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max (Note 5)	−30	−130	mA
I_{CC}	Supply Current	V_{IN} = 0 V, Outputs Open (I_{OUT} = 0 mA) V_{CC} = Max		180	mA

Notes:

2. *For APL Products, Group A, Subgroups 1, 2, and 3 are tested per MIL-STD-883, Method 5005, unless otherwise noted.*
3. *V_{IL} and V_{IH} are input conditions of output tests and are not themselves directly tested. V_{IL} and V_{IH} are absolute voltages with respect to device ground and include all overshoots due to system and/or tester noise. Do not attempt to test these values without suitable equipment.*
4. *I/O pin leakage is the worst case of I_{IL} and I_{OZL} (or I_{IH} and I_{OZH}).*
5. *Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. V_{OUT} = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.*

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CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions		Typ	Unit
C_{IN}	Input Capacitance	V_{IN} = 2.0 V	V_{CC} = 5.0 V, T_A = 25°C, f = 1 MHz	9	pF
C_{OUT}	Output Capacitance	V_{OUT} = 2.0 V		10	

Note:

1. *These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.*

SWITCHING CHARACTERISTICS over MILITARY operating ranges (Note 2)

Parameter Symbol	Parameter Description				Min	Max	Unit
t_{PD}	Input or Feedback to Combinatorial Output			16L8, 16R6, 16R4		20	ns
t_S	Setup Time from Input or Feedback to Clock			16L8, 16R6, 16R4	20		ns
t_H	Hold Time				0		ns
t_{CO}	Clock to Output or Feedback					15	ns
t_{WL}	Clock Width	LOW			12		ns
t_{WH}		HIGH			12		ns
f_{MAX}	Maximum Frequency (Note 3)	External Feedback	$1/(t_S + t_{CO})$		28.5		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		41.6		MHz
t_{PZX}	$\overline{OE}$ to Output Enable (Note 4)					20	ns
t_{PXZ}	$\overline{OE}$ to Output Disable (Note 4)					20	ns
t_{EA}	Input to Output Enable Using Product Term Control (Note 4)			16L8, 16R6, 16R4		25	ns
t_{ER}	Input to Output Disable Using Product Term Control (Note 4)					20	ns

Notes:

2. *See Switching Test Circuit for test conditions. For APL products Group A, Subgroups 9, 10, and 11 are tested per MIL-STD-883, Method 5005, unless otherwise noted.*
3. *These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.*
4. *These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where these parameters may be affected.*

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ABSOLUTE MAXIMUM RATINGS

Storage Temperature ..... −65°C to +150°C

Ambient Temperature with Power Applied ..... −55°C to +125°C

Supply Voltage with Respect to Ground ..... −0.5 V to +7.0 V

DC Input Voltage ..... −1.5 V to +5.5 V

DC Output or I/O Pin Voltage ..... 5.5 V

Stresses above those listed under Absolute Maximum Ratings may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to Absolute Maximum Ratings for extended periods may affect device reliability. Programming conditions may differ. Absolute Maximum Ratings are for system design reference; parameters given are not tested.

OPERATING RANGES

Military (M) Devices (Note 1)

Ambient Temperature (T_A) Operating in Free Air ..... −55°C Min

Operating Case (T_C) Temperature ..... 125°C Max

Supply Voltage (V_{CC}) with Respect to Ground ..... +4.50 V to +5.50 V

Note:

1. Military products are tested at T_C = +25°C, +125°C, and −55°C, per MIL-STD-883.

Operating ranges define those limits between which the functionality of the device is guaranteed.

DC CHARACTERISTICS over MILITARY operating ranges unless otherwise specified (Note 2)

Parameter Symbol	Parameter Description	Test Conditions	Min	Max	Unit
V_{OH}	Output HIGH Voltage	I_{OH} = −2 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 12 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 3)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 3)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = −18 mA, V_{CC} = Min		−1.5	V
I_{IH}	Input HIGH Current	V_{IN} = 2.4 V, V_{CC} = Max (Note 4)		25	µA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max (Note 4)		−250	µA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max		1	mA
I_{OZH}	Off-State Output Leakage Current HIGH	V_{OUT} = 2.4 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 4)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 4)		−100	µA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max (Note 5)	−30	−130	mA
I_{CC}	Supply Current	V_{IN} = 0 V, Outputs Open (I_{OUT} = 0 mA) V_{CC} = Max		90	mA

Notes:

2. For APL Products, Group A, Subgroups 1, 2, and 3 are tested per MIL-STD-883, Method 5005, unless otherwise noted.

3. V_{IL} and V_{IH} are input conditions of output tests and are not themselves directly tested. V_{IL} and V_{IH} are absolute voltages with respect to device ground and include all overshoots due to system and/or tester noise. Do not attempt to test these values without suitable equipment.

4. I/O pin leakage is the worst case of I_{IL} and I_{OZL} (or I_{IH} and I_{OZH}).

5. Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. V_{OUT} = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.

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CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions		Typ	Unit
C_{IN}	Input Capacitance	V_{IN} = 2.0 V	V_{CC} = 5.0 V, T_A = 25°C, f = 1 MHz	7	pF
C_{OUT}	Output Capacitance	V_{OUT} = 2.0 V		7	

Note:

1. *These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.*

SWITCHING CHARACTERISTICS over MILITARY operating ranges (Note 2)

Parameter Symbol	Parameter Description				Min	Max	Unit
t_{PD}	Input or Feedback to Combinatorial Output			16L8, 16R6, 16R4		30	ns
t_S	Setup Time from Input or Feedback to Clock			16L8, 16R6, 16R4	30		ns
t_H	Hold Time				0		ns
t_{CO}	Clock to Output or Feedback					20	ns
t_{WL}	Clock Width	LOW			20		ns
t_{WH}		HIGH			20		ns
f_{MAX}	Maximum Frequency (Note 3)	External Feedback	$1/(t_S + t_{CO})$		20		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		25		MHz
t_{PZX}	$\overline{OE}$ to Output Enable (Note 4)					25	ns
t_{PXZ}	$\overline{OE}$ to Output Disable (Note 4)					25	ns
t_{EA}	Input to Output Enable Using Product Term Control (Note 4)			16L8, 16R6, 16R4		30	ns
t_{ER}	Input to Output Disable Using Product Term Control (Note 4)					30	ns

Notes:

2. *See Switching Test Circuit for test conditions. For APL products Group A, Subgroups 9, 10, and 11 are tested per MIL-STD-883, Method 5005, unless otherwise noted.*
3. *These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.*
4. *These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where these parameters may be affected.*

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ABSOLUTE MAXIMUM RATINGS

Storage Temperature ..... –65°C to +150°C

Ambient Temperature with Power Applied ..... –55°C to +125°C

Supply Voltage with Respect to Ground ..... –0.5 V to + 7.0 V

DC Input Voltage ..... –1.5 V to + 5.5 V

DC Output or I/O Pin Voltage ..... 5.5 V

Stresses above those listed under Absolute Maximum Ratings may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to Absolute Maximum Ratings for extended periods may affect device reliability. Programming conditions may differ. Absolute Maximum Ratings are for system design reference; parameters given are not tested.

OPERATING RANGES

Military (M) Devices (Note 1)

Ambient Temperature (T_A) Operating in Free Air ..... –55°C Min

Operating Case (T_C) Temperature ..... 125°C Max

Supply Voltage (V_{CC}) with Respect to Ground ..... +4.50 V to +5.50 V

Note:

1. Military products are tested at T_C = +25°C, +125°C, and –55°C, per MIL-STD-883.

Operating ranges define those limits between which the functionality of the device is guaranteed.

DC CHARACTERISTICS over MILITARY operating ranges unless otherwise specified (Note 2)

Parameter Symbol	Parameter Description	Test Conditions	Min	Max	Unit
V_{OH}	Output HIGH Voltage	I_{OH} = –2 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 12 mA V_{IN} = V_{IH} or V_{IL} V_{CC} = Min		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 3)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 3)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = –18 mA, V_{CC} = Min		–1.5	V
I_{IH}	Input HIGH Current	V_{IN} = 2.4 V, V_{CC} = Max (Note 4)		25	µA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max (Note 4)		–250	µA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max		1	mA
I_{OZH}	Off-State Output Leakage Current HIGH	V_{OUT} = 2.4 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 4)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max V_{IN} = V_{IH} or V_{IL} (Note 4)		–100	µA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max (Note 5)	–30	–130	mA
I_{CC}	Supply Current	V_{IN} = 0 V, Outputs Open (I_{OUT} = 0 mA) V_{CC} = Max		180	mA

Notes:

2. For APL Products, Group A, Subgroups 1, 2, and 3 are tested per MIL-STD-883, Method 5005, unless otherwise noted.

3. V_{IL} and V_{IH} are input conditions of output tests and are not themselves directly tested. V_{IL} and V_{IH} are absolute voltages with respect to device ground and include all overshoots due to system and/or tester noise. Do not attempt to test these values without suitable equipment.

4. I/O pin leakage is the worst case of I_{IL} and I_{OZL} (or I_{IH} and I_{OZH}).

5. Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. V_{OUT} = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.

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CAPACITANCE (Note 1)

Parameter Symbol	Parameter Description	Test Conditions		Typ	Unit
C_{IN}	Input Capacitance	V_{IN} = 2.0 V	V_{CC} = 5.0 V T_A = 25°C f = 1 MHz	7	pF
C_{OUT}	Output Capacitance	V_{OUT} = 2.0 V		7	

Note:

1. *These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where capacitance may be affected.*

SWITCHING CHARACTERISTICS over MILITARY operating ranges (Note 2)

Parameter Symbol	Parameter Description				Min	Max	Unit
t_{PD}	Input or Feedback to Combinatorial Output			16L8, 16R6, 16R4		30	ns
t_S	Setup Time from Input or Feedback to Clock			16L8, 16R6, 16R4	30		ns
t_H	Hold Time				0		ns
t_{CO}	Clock to Output or Feedback					20	ns
t_{WL}	Clock Width	LOW			20		ns
t_{WH}		HIGH			20		ns
f_{MAX}	Maximum Frequency (Note 3)	External Feedback	$1/(t_S + t_{CO})$		20		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		25		MHz
t_{PZX}	$\overline{OE}$ to Output Enable (Note 4)					25	ns
t_{PXZ}	$\overline{OE}$ to Output Disable (Note 4)					25	ns
t_{EA}	Input to Output Enable Using Product Term Control (Note 4)			16L8, 16R6, 16R4		30	ns
t_{ER}	Input to Output Disable Using Product Term Control (Note 4)					30	ns

Notes:

2. *See Switching Test Circuit for test conditions. For APL products Group A, Subgroups 9, 10, and 11 are tested per MIL-STD-883, Method 5005, unless otherwise noted.*
3. *These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.*
4. *These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where these parameters may be affected.*

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ABSOLUTE MAXIMUM RATINGS

Storage Temperature ..... –65°C to +150°C

Ambient Temperature with Power Applied ..... –55°C to +125°C

Supply Voltage with Respect to Ground ..... –0.5 V to + 7.0 V

DC Input Voltage ..... –1.5 V to + 5.5 V

DC Output or I/O Pin Voltage ..... 5.5 V

Stresses above those listed under Absolute Maximum Ratings may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to Absolute Maximum Ratings for extended periods may affect device reliability. Programming conditions may differ. Absolute Maximum Ratings are for system design reference; parameters given are not tested.

OPERATING RANGES

Military (M) Devices (Note 1)

Ambient Temperature (T_A) Operating in Free Air ..... –55°C Min

Operating Case (T_C) Temperature ..... 125°C Max

Supply Voltage (V_{CC}) with Respect to Ground ..... +4.50 V to +5.50 V

Note:

1. Military products are tested at T_C = +25°C, +125°C, and –55°C, per MIL-STD-883.

Operating ranges define those limits between which the functionality of the device is guaranteed.

DC CHARACTERISTICS over MILITARY operating ranges unless otherwise specified (Note 2)

Parameter Symbol	Parameter Description	Test Conditions	Min	Max	Unit
V_{OH}	Output HIGH Voltage	I_{OH} = –1 mA V_{IN} = V_{IH} or V_{IL}, V_{CC} = Min	2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 4 mA V_{IN} = V_{IH} or V_{IL}, V_{CC} = Min		0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH Voltage for all Inputs (Note 3)	2.0		V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW Voltage for all Inputs (Note 3)		0.8	V
V_I	Input Clamp Voltage	I_{IN} = –18 mA, V_{CC} = Min		–1.5	V
I_{IH}	Input HIGH Current	V_{IN} = 2.4 V, V_{CC} = Max (Note 4)		25	µA
I_{IL}	Input LOW Current	V_{IN} = 0.4 V, V_{CC} = Max (Note 4)		–250	µA
I_I	Maximum Input Current	V_{IN} = 5.5 V, V_{CC} = Max		1	mA
I_{OZH}	Off-State Output Leakage Current HIGH	V_{OUT} = 2.4 V, V_{CC} = Max, V_{IN} = V_{IH} or V_{IL} (Note 4)		100	µA
I_{OZL}	Off-State Output Leakage Current LOW	V_{OUT} = 0.4 V, V_{CC} = Max, V_{IN} = V_{IH} or V_{IL} (Note 4)		–100	µA
I_{SC}	Output Short-Circuit Current	V_{OUT} = 0.5 V, V_{CC} = Max (Note 5)	–30	–250	mA
I_{CC}	Supply Current	V_{IN} = 0 V, Outputs Open (I_{OUT} = 0 mA), V_{CC} = Max		55	mA

Notes:

2. For APL Products, Group A, Subgroups 1, 2, and 3 are tested per MIL-STD-883, Method 5005, unless otherwise noted.

3. V_{IL} and V_{IH} are input conditions of output tests and are not themselves directly tested. V_{IL} and V_{IH} are absolute voltages with respect to device ground and include all overshoots due to system and/or tester noise. Do not attempt to test these values without suitable equipment.

4. I/O pin leakage is the worst case of I_{IL} and I_{OZL} (or I_{IH} and I_{OZH}).

5. Not more than one output should be tested at a time. Duration of the short-circuit should not exceed one second. V_{OUT} = 0.5 V has been chosen to avoid test problems caused by tester ground degradation.

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SWITCHING CHARACTERISTICS over MILITARY operating ranges (Note 1)

Parameter Symbol	Parameter Description				Min	Max	Unit
t_{PD}	Input or Feedback to Combinatorial Output			16L8, 16R6, 16R4		50	ns
t_S	Setup Time from Input or Feedback to Clock			16L8, 16R6, 16R4	50		ns
t_H	Hold Time				0		ns
t_{CO}	Clock to Output or Feedback					25	ns
t_{WL}	Clock Width	LOW			25		ns
t_{WH}		HIGH			25		ns
f_{MAX}	Maximum Frequency (Note 2)	External Feedback	$1/(t_S + t_{CO})$		13.3		MHz
		No Feedback	$1/(t_{WH} + t_{WL})$		20		MHz
t_{PZX}	$\overline{OE}$ to Output Enable (Note 3)					25	ns
t_{PXZ}	$\overline{OE}$ to Output Disable (Note 3)					25	ns
t_{EA}	Input to Output Enable Using Product Term Control (Note 3)			16L8, 16R6, 16R4		45	ns
t_{ER}	Input to Output Disable Using Product Term Control (Note 3)					45	ns

Notes:

1. *See Switching Test Circuit for test conditions. For APL products Group A, Subgroups 9, 10, and 11 are tested per MIL-STD-883, Method 5005, unless otherwise noted.*
2. *These parameters are not 100% tested, but are calculated at initial characterization and at any time the design is modified where frequency may be affected.*
3. *These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where these parameters may be affected.*

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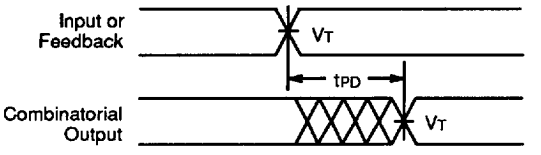
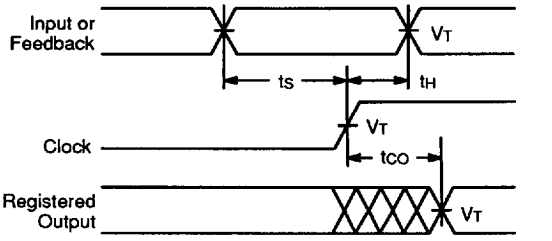
SWITCHING WAVEFORMS



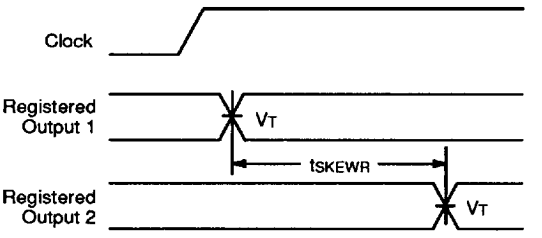
16492C-12

Combinatorial Output



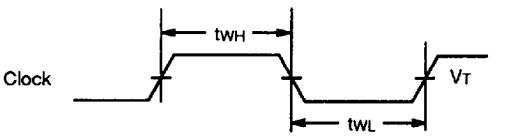
16492C-13

Registered Output



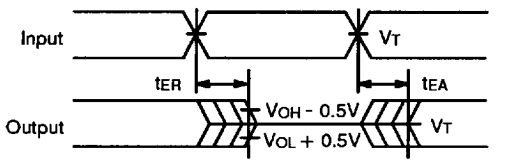
16492C-14

Registered Output Skew



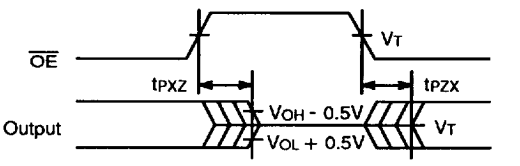
16492C-15

Clock Width



16492C-16

Input to Output Disable/Enable



16492C-17

$\overline{OE}$ to Output Disable/Enable

Notes:

1. V_T = 1.5 V
2. Input pulse amplitude 0 V to 3.0 V
3. Input rise and fall times 2 ns–3 ns typical.

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KEY TO SWITCHING WAVEFORMS

WAVEFORM	INPUTS	OUTPUTS
	Must be Steady	Will be Steady
	May Change from H to L	Will be Changing from H to L
	May Change from L to H	Will be Changing from L to H
	Don't Care, Any Change Permitted	Changing, State Unknown
	Does Not Apply	Center Line is High-Impedance "Off" State

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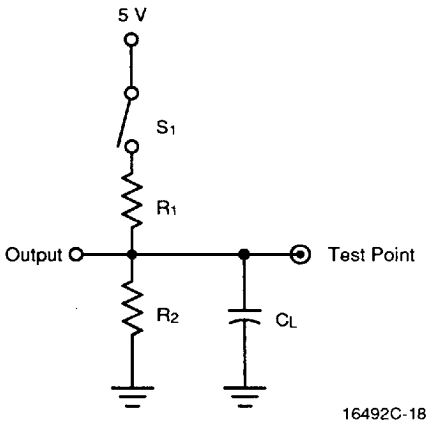
SWITCHING TEST CIRCUIT



16492C-18

Specification	S_1	C_L	Commercial		Military		Measured Output Value
			R_1	R_2	R_1	R_2	
t_{PD}, t_{CO}	Closed	50 pF	All but B-4: 200 Ω	All but B-4: 390 Ω	All but B-4: 390 Ω	All but B-4: 750 Ω	1.5 V
t_{PZX}, t_{EA}	Z → H: Open Z → L: Closed						
t_{PXZ}, t_{ER}	H → Z: Open L → Z: Closed	5 pF	B-4: 800 Ω	B-4: 1.56 kΩ	B-4: 800 Ω	B-4: 1.56 kΩ	H → Z: V_{OH} – 0.5 V L → Z: V_{OL} + 0.5 V

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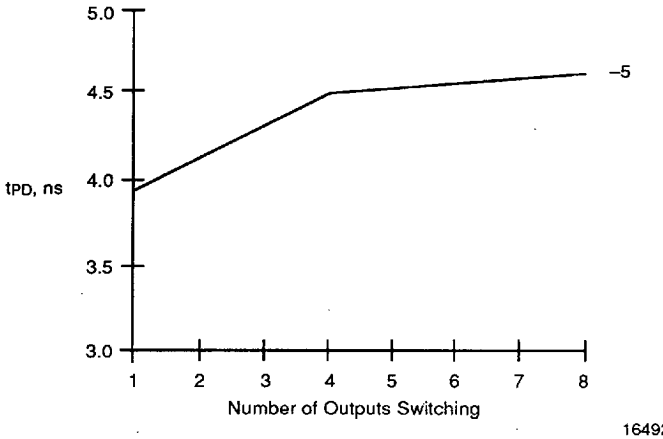
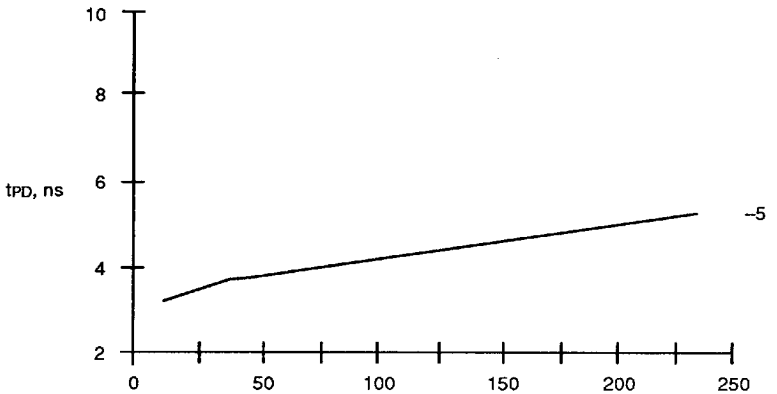
MEASURED SWITCHING CHARACTERISTICS for the PAL16R8-5

V_{CC} = 4.75 V, T_A = 75°C (Note 1)



16492C-19

t_{PD} vs. Number of Outputs Switching



16492C-20

t_{PD} vs. Load Capacitance
V_{CC} = 5.25 V, T_A = 25°C

Note:

1. *These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where t_{PD} may be affected.*

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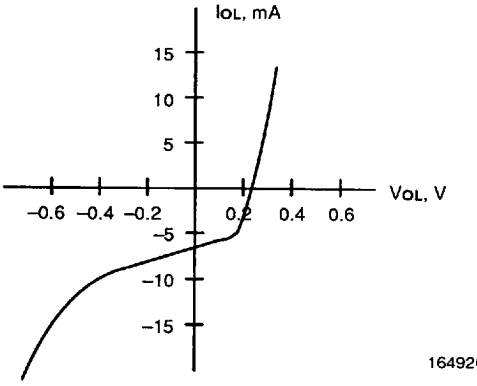
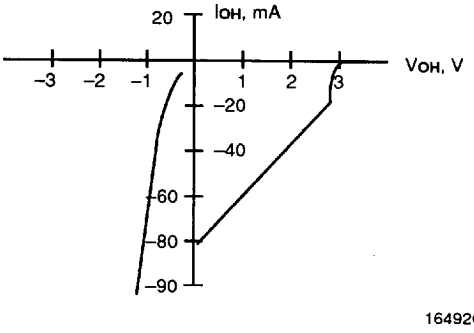
CURRENT VS. VOLTAGE (I-V) CHARACTERISTICS for the PAL16R8-4/5

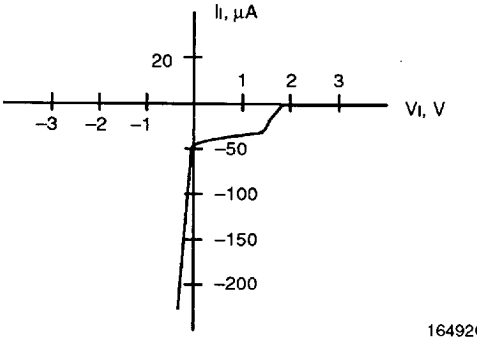
V_{CC} = 5.0 V, T_A = 25°C



Output, LOW



Output, HIGH



Input

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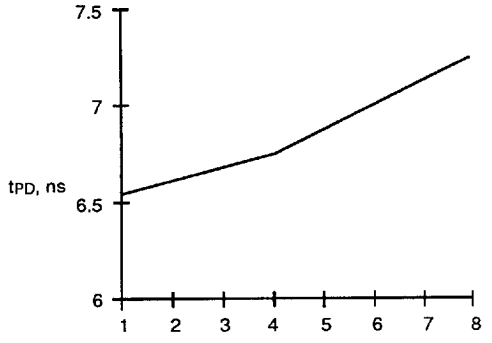
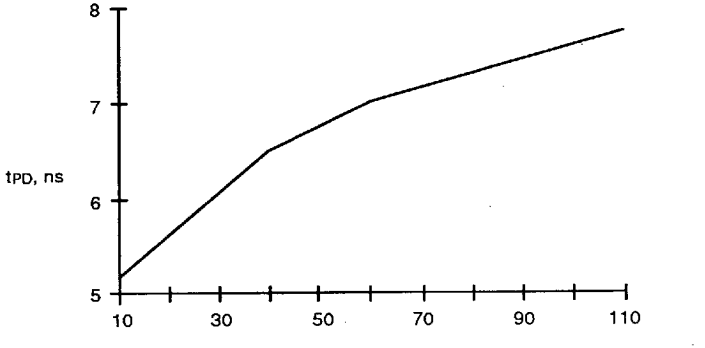
MEASURED SWITCHING CHARACTERISTICS for the PAL16R8-7

V_{CC} = 4.75 V, T_A = 75°C (Note 1)



16492C-24

t_{PD} vs. Number of Outputs Switching



16492C-25

t_{PD} vs. Load Capacitance

Note:

1. *These parameters are not 100% tested, but are evaluated at initial characterization and at any time the design is modified where t_{PD} may be affected.*

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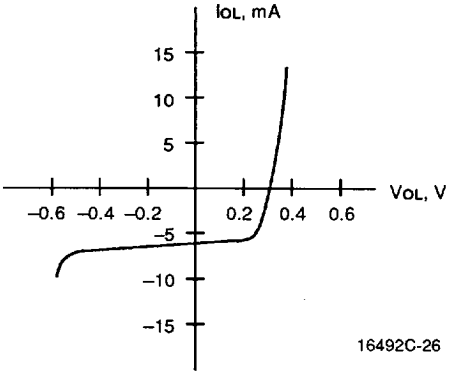
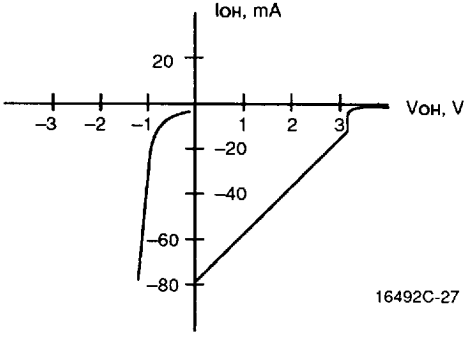
CURRENT VS. VOLTAGE (I-V) CHARACTERISTICS for the PAL16R8-7

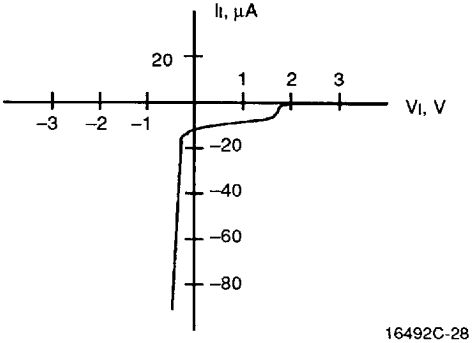
V_{CC} = 5.0 V, T_A = 25°C



Output, LOW



Output, HIGH



Input

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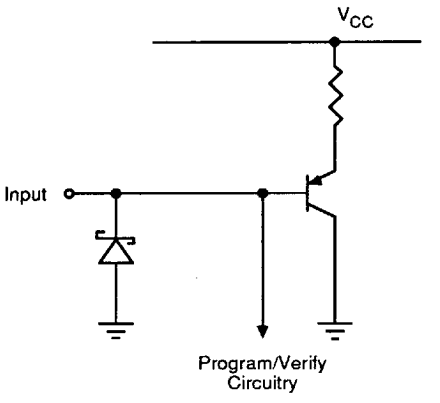
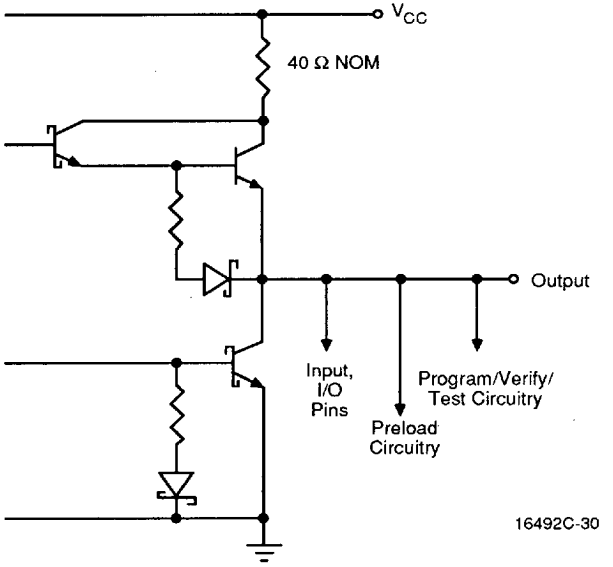
INPUT/OUTPUT EQUIVALENT SCHEMATICS



Typical Input



Typical Output

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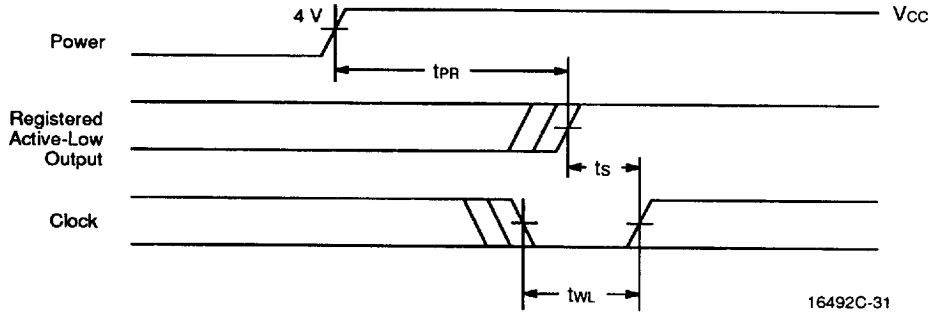
POWER-UP RESET

The power-up reset feature ensures that all flip-flops will be reset to LOW after the device has been powered up. The output state will be HIGH due to the inverting output buffer. This feature is valuable in simplifying state machine initialization. A timing diagram and parameter table are shown below. Due to the synchronous operation of the power-up reset and the wide range of ways V_{CC} can rise to its steady state, two conditions are required to ensure a valid power-up reset. These conditions are:

- The V_{CC} rise must be monotonic.
- Following reset, the clock input must not be driven from LOW to HIGH until all applicable input and feedback setup times are met.

Parameter Symbol	Parameter Description	Max	Unit
t_{PR}	Power-Up Reset Time	1000	ns
t_S	Input or Feedback Setup Time	See Switching Characteristics	
t_{WL}	Clock Width LOW		



Power-Up Reset Waveform

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